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Evaluation of the multiplier used in the National Park Service's Money Generation Model

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Evaluation of the Multiplier used in the National Park Service's

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For the past fourteen years the National Park Service has maintained an economic impact model know as the Money Generation Model or MGM. The MGM is an easy-to-use economic impact model which generates very rough estimates of the impact of national park visitor spending on local economies. The model uses data on percent of nonlocal visitation, visitor expenditures and length of stay by visitors combined with an indirect and induced spending multiplier to generate visitor expenditure impacts. All four elements of the MGM need to be addressed to validate the accuracy of the MGM. This thesis focuses on the question of the multiplier used in the MGM.

The multipliers in the MGM are adjusted to local gateway community multipliers from the U.S. Bureau of Economic Analysis's RIMS II state multipliers. The method used for this adjustment is informal and undocumented, based primarily on the experience of National Park Service personnel. It is the validity and accuracy of the local community multipliers used in the MGM that this thesis addresses.

Regression analysis against a standard multiplier generated by IMPLAN, as well as measures of economic completeness such as population, number of sectors in an economy, county metropolitan classification, and park community rural classification is used to determine the validity of the MGM's multipliers and to determine the MGM's definition of the local impact area.

The results indicate that the MGM multipliers are as valid as any other computer generated multiplier. In addition, the MGM multipliers do appear to be at the community level. However, the multipliers do not include all communities with access to a park that might be impacted by nonlocal visitors.

Finally, a systematic method for multiplier adjustment is developed that provides multipliers that are statistically equivalent to the present MGM multipliers.

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Chapter 1 Statement of the Problem

1.1 Background on the MGM

The U.S. National Park Service (NPS) uses a regional economic impact model known as the Money Generation Model (MGM) to estimate the economic impact of nonlocal visitors on gateway and adjacent communities. For example, NPS could use the MGM to estimate the tourism impact of Yellowstone National Park on the community of West Yellowstone, Montana. That community economic analysis would include only the immediate gateway, not more distant urban areas such as Bozeman, Montana or other parts of Gallatin County, Montana.

The MGM is not a complicated model. It is essentially an economic base model that uses input-output multipliers. Economic base models assume that regional economic growth is dependent on income injected into the local economy from outside sources. Although these models have come under serious fire since their first inception in 1916, economics has not offered more suitable alternatives for what the users of these models seek—namely, an adaptable, relatively easy estimate of local economic impacts.

The MGM can estimate three types of nonlocal expenditure impacts: total sales impact, tax impact, and jobs impact. This thesis addresses only the total sales impact estimated by the MGM, and any subsequent references to the MGM refer only to the sales impact. Retail sales impact refers to changes in the total volume of sales in a community due to changes in expenditures from outside the community. The retail sales impact is the most important and the most complicated of the three impacts estimated by the MGM. This is because the sales impact is calculated from four elements which can each introduce a number of biases. The other two estimates are simply multiplicative derivations from the sales impact.

1.2 Problems in the MGM

The MGM has been used by NPS for fourteen years. For better or worse the MGM has become popular among tourism and environmental groups during its tenure. Since policy makers desire economic impact estimates and the MGM has become a popular tool for this, the model needs to be assessed for its accuracy and validity.

The four elements of the MGM used to estimate the retail sales impact are: 1) the percent of visitors that are "nonlocal", 2) recreation visitor day (RVD) volume, 3) average expenditures per visitor, and 4) the indirect and induced (I&I) multiplier. Each element possesses its own unique problems. The problem with the element measuring the percent of visitors that are nonlocal is that the definition of "nonlocal" may be used inappropriately. In addition recreation visitor day volume may not accurately represent park "visitation," and the source of average expenditure data may be inappropriate. Finally, the multiplier may simply be incorrect. Table 1-1 summarizes the direction of each element's possible bias and the explanation for this bias.

Elements	*Bias Direction*	*Reason*
Percent Nonlocal	Up	Nearby nonlocals don't spend like other tourists because they live close enough for day trips to a site.
RVD Volume	Down	If the visit is the highlight of a trip, then visitors will likely spend significant time in the local community eating, drinking, and shopping.
	Up	Parks along major roadways: visitor spending patterns may be virtually zero because the visit is unintended.
Expenditure	Down	The measure does not include many tourist expenditures such as souvenirs, etc.
	Up	Estimates are for business travelers. They are not for vacationers who may camp in many places and make some of their own meals.
Multiplier	Unknown	Among other unknown variables, it depends upon the appropriate geographic definition of the impacted economy.

Table 1-1: Bias in the MGM total sales benefit estimate

Currently, the NPS takes RIMS II state-wide multipliers and informally adjusts them down to approximate the appropriate local multipliers. This ad hoc multiplier modification is informally based on the personal experience with multipliers of the creator of the MGM, Dr. Hornback. As a result the accuracy of the nonlocal multiplier is unknown.

The best means of obtaining data for three of the elements (percent nonlocal, RVD, and average expenditure) is surveying individual parks and their visitors. Surveying all of the parks lies beyond the scope of this thesis. Even if accurate survey data were available—the University of Idaho's Visitor Service Project has survey data for some parks—the multiplier would still be problematic. Even though there is abundant room for research into the first three elements of the MGM noted above, this thesis focuses solely on the persistent problem associated with the multiplier.

1.3 Thesis objective and expected findings

The computer program IMPLAN Pro, maintained by the Minnesota IMPLAN Group, is used to estimate county multipliers for nearly all three hundred twenty-nine national parks. These multipliers are then tested against the NPS's modified RIMS II multipliers to see if they are statistically different. A regression analysis of the RIMS II multipliers is run against measurements of economic completeness such as the calculated IMPLAN multipliers, number of industrial sectors, population, metropolitan classification, and other demographics such as county size and a park's rural or urban characteristic. This is done to determine any systematic justification for the RIMS II park multipliers. Assuming that IMPLAN and RIMS II provide equivalent multipliers, the IMPLAN county multipliers are expected to be larger than the RIMS II park multipliers. This is because the study area for the IMPLAN multipliers is at the larger county level, whereas the study area for the RIMS II park multipliers is at the smaller individual gateway community level. This conclusion, however, is under the assumption that the two models are equivalent. The validity of this assumption is discussed below.

The regressions in this thesis also provide a way of estimating park multipliers without the expertise of Dr. Hornback or even the RIMS II state multipliers. An adjusted MGM is run to demonstrate the extent of difference involved in using the IMPLAN multipliers or the new estimated park multipliers in place of the MGM's informally approximated RIMS II park multipliers.

1.4 Comparing RIMS II and IMPLAN in the context of the MGM

Both RIMS II and the current version of IMPLAN Pro, Version 1.1, produce standard Type II input-output multipliers for output, employment, and earnings. This, however, is a very recent development. Prior to 1996, IMPLAN only calculated Type III multipliers. Since the development of IMPLAN software capable of calculating Type II multipliers is such a recent phenomenon, no studies are available that compare the new IMPLAN Type II multipliers to any other packaged input-output models. This means that the literature review of IMPLAN and RIMS II can address only the older version of IMPLAN that produces Type III multipliers. All references to IMPLAN in the literature review below refer to the older version of IMPLAN.

An additional problem in comparing IMPLAN to the MGM's RIMS II park multipliers is that this thesis applies IMPLAN at the county level, not the zip code level. In theory the MGM's informally approximated RIMS II park multipliers are intended to be zip code level multipliers for "gateway" communities. The gateway community may include a single zip code for rural areas or multiple zip codes for large metropolitan areas. For many rural parks, where the town essentially is the county trade center, this should make no difference. Even for other NPS units, the county-zip code inconsistency should not pose a barrier to comparing the multipliers. I do not, however, expect the two sets of multipliers to be identical. The county multipliers encompass larger economic units than the park multipliers. This should make the county multipliers slightly larger than the park multipliers.

A further problem with comparing multipliers is the ambiguity of NPS's definition of gateway community. NPS does not indicate for which communities it estimates impacts. This means I must decide which communities were considered “gateways” in the design of the MGM. Glacier National Park can illustrate this problem. East Glacier, West Glacier, Babb, St. Mary, and Polebridge are obvious gateway communities. Does the MGM estimate an aggregate impact on all of these or just one or two of these. In addition, Columbia Falls, Hungry Horse, Martin City, and Coram are very close to the park’s west entrance and offer many more services to park visitors than all the gateway communities combined. Does the MGM estimate include these towns in their impact analysis? Considering the likelihood that park visitors spend time and money in these nearby towns, a park impact analysis certainly should include them. There is, however, no way of knowing for certain whether the MGM estimate includes these towns. Although this may seem like a large stumbling block to analysis, it is important to keep in mind that large parks such as Glacier are not typical of NPS units. Well over half of all NPS units are small parks located within or just outside of a single community. Furthermore, the underlying purpose of the multiplier comparison is to find a systematic replacement for the current ad hoc method, not to simply replicate the MGM’s informally approximated multiplier.

1.5 RIMS II versus IMPLAN

Three methodological differences exist between RIMS II and IMPLAN: (1) They specify different closure rules in calculating the multipliers; (2) They use different techniques to regionalize the national technical coefficients; (3) They use different sources of data to build the models. It is important to note an additional difference when reviewing the literature. Articles comparing RIMS II and IMPLAN only address IMPLAN Type III multipliers. The recent development of IMPLAN to calculate Type II multipliers bridges the methodological differences associated with the two different multipliers but creates a gap in what the existing literature can tell us about current IMPLAN multipliers relative to RIMS II. Nevertheless, the differences in Type II and Type III multipliers needs to be addressed.

According to Rickman et al. (1995) the difference between RIMS II and IMPLAN is that the standard Type II multiplier assumes that the consumption function is linear. Type III multipliers, on the other hand, assume that the marginal propensity to consume is not constant, but, rather, that it decreases as income in the region rises. Borgen and Cooke (1990) claim that the difference between Type II multipliers and IMPLAN Type III multipliers is that Type III multipliers implicitly assume that the economy in a region is at full employment. Type II multipliers, on the other hand, assume that the economy is at less than full employment. These differences do not affect either multiplier's use in the MGM, because both multipliers are still estimates of the same indirect and induced effects of money injections. The two multipliers only affect the size of the MGM estimated impacts. According to Olson (1989) Type III multipliers can be expected to be five to fifteen percent less than standard Type II multipliers[1].

My purpose is not to evaluate which multiplier performs better; that is an ongoing debate. I only wish to show the extent of difference–if any–in the MGM estimates when a

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[1] Citation from Brucker, Hastings and Latham (1990).

systematic multiplier is used versus the informally approximated multiplier generated by Dr. Hornback.

The following review of the literature reveals the direction of the differences between RIMS II and IMPLAN is ambiguous over-all. However, when concentrating on only the Hotel/Lodging and Amusement and Eating/Drinking sectors, IMPLAN produces larger multipliers than RIMS II. Considering the diversity of results in the literature, just how much higher IMPLAN multipliers can be expected to be is unknown.

Chapter 2 Review of the Literature

2.1 RIMS II and IMPLAN

In the past decade the supply of ready-made regional impact models has grown to include a wide variety of input-output models for users to choose from. The U.S. Department of Commerce/Bureau of Economic Analysis's Regional Input-Output Modeling System (RIMS II) and the U.S. Department of Agriculture/Forest Service developed IMPLAN model are among the most widely used input-output models[2].

Despite the wide spread application of both RIMS II and IMPLAN for more than ten years, neither model can be judged more or less accurate than the other. The impossibility of measuring the accuracy of IMPLAN versus RIMS II has caused most authors to concentrate on the relative costs and features of these models and to focus on these models' performance against the presumed more accurate survey based models. Nevertheless, a few authors have compared and contrasted the methodology and performance of these two models.

Brucker, Hastings and Latham (1990) are among the first authors to try to illuminate the "black boxes" of ready-made input-output models. They compare methodology and estimate impacts from five regional ready-made models. The models considered in their analysis are RIMS II, ADOTMATR, RSRI, IMPLAN, and SCHAFFER.

Two methods of comparison are used. Acknowledging that their is no recognized

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[2] "In a survey of input-output models in use, Buress et al. (1988) reported that IMPLAN and REMI (developed by Regional Economic Models, Inc.) were the two most widely used models. RIMS II multipliers also are viewed as widely used in economic impact studies" (Rickman and Schwer 1995).

way to identify actual impacts--and thus no way of comparing the true accuracy of the model estimates--the authors resort to the precedent in the literature of assuming a survey based model is more accurate than a non-survey based model. Their second method of comparison is against the five model mean. This, they claim, allows comparison of the impact similarities between models.

The impacts estimated for the comparison with the survey based model are for final demand changes in petroleum refining and computer equipment for Texas. Output, income and employment impacts are all estimated. The income and employment impacts are more divergent between models and from the survey based model than the output multipliers. IMPLAN came closest to the survey based model in three of the six impact estimates, but only by very small margins in some cases. In output estimates, IMPLAN came closest to the survey based model.

RIMS II and IMPLAN perform with the most similarity. The difference in petroleum refining impact is only 1.7%. The difference between the two impacts of computer equipment on output is higher at 12%. Among the five models evaluated, however, this is still more similar than the other models. The authors caution that IMPLAN should not be considered the superior model simply because it came closest to the survey based model half the time. If a six-measure average deviation from the survey based model is calculated, RIMS II and RSRI would have the lowest average deviations from the survey based model.

Since a major difference among models is the regionalizing procedure[3], the authors

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[3] RIMS II uses location quotient techniques while IMPLAN uses regional purchase coefficients.

hypothesized that estimates for more self-sufficient regions--requiring less adjustment for trade patterns--will be more similar. The survey based model indicates that the petroleum refining industry imports 38 percent of its total purchases, while the computer equipment industry is more self-sufficient, importing only 19 percent of its total purchases. The authors note the fact that the computer equipment industry yields the most disparate impact estimates may indicate that regional trade pattern adjustment is not as important as other variables such as similarity to the national industry.

To compare the five models to each other—against the five model mean—the authors estimate output, income and employment impacts across seven region and industry combinations. The notable results from this are that the IMPLAN output impacts are consistently below the RIMS II output impacts, but the IMPLAN income and employment impacts are consistently above RIMS II.

The authors' conclude that the five models' estimates are closer to each other for output and income impacts than for employment impacts. Furthermore, even when using the survey based model as a proxy for accuracy, the "question of which model is the most accurate remains moot." The only conclusion I can make after separating out the RIMS II and IMPLAN results is that the two models are very similar, although IMPLAN output estimates are consistently less than RIMS II, while IMPLAN income and employment estimates are consistently higher.

In the same year that Brucker et al. (1990) published their paper, Borgen and Cooke completed a paper entitled "The Comparison of IMPLAN and RIMS II Output Multipliers for the State of Idaho." Their paper compares the 1989 release of IMPLAN and presumably the equivalent year's multipliers from RIMS II for thirty-five sectors in the

Idaho economy. They compare both hand calculated IMPLAN Type II and the default IMPLAN Type III output multipliers to RIMS II Type II output multipliers.

The authors recognize three differences in the models that may contribute to different estimates: source and type of data, procedures for scaling the national technical coefficients, and means of closing the models. The authors minimize the closure differences by applying the RIMS II closure assumptions to the IMPLAN model[4]. This allows their analysis to focus on data and regionalizing procedures.

The authors calculated IMPLAN Type II multipliers to control for the treatment of employment in Type II and Type III multipliers. Type III multipliers implicitly assume that the economy in a region is at full employment. Type II multipliers assume that the economy is at less than full employment. The authors note from Olson (1989) that this difference usually leads to Type III multipliers being five to fifteen percent less than Type II multipliers.

The authors feel that the major source of difference between IMPLAN and RIMS II is the techniques used to regionalize the national coefficients. IMPLAN uses a variation of the Regional Purchase Coefficient (RPC) technique. The RPC method calculates values based on an area's population, land area, employee compensation, and employment numbers. In deriving import and exports, a constraint is imposed so that the calculated RPC's are not greater than the supply-demand pool ratio of any specific industry. RIMS II uses a simpler location quotient (LQ) technique to regionalize its data. The LQ assumes the output needs of a specific industry in a region are relative to the output needs for each industry nationally. The authors note that comparisons between supply-demand pool and

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[4] The authors do not explain their methodology.

LQs show that they are conceptually equivalent. Since IMPLAN's RPCs are constrained by supply-demand pool ratios, the RPC approach should always generate regional coefficients that are less than or equal to supply-demand pool coefficients. Thus, if this is true, the IMPLAN Type II multipliers will be on average less than RIMS II. This implies that the default IMPLAN Type III multipliers will also be smaller than RIMS II multipliers.

A final difference that the authors hypothesize should make RIMS II multipliers higher than IMPLAN Type II multipliers--and therefore higher than IMPLAN Type III multipliers too--is the treatment of foreign imports. IMPLAN uses only domestic trade flows, while RIMS II multipliers include both domestic and foreign transactions.

The effects of several additional differences are ambiguous. Even though aggregation schemes are designed to be identical, they are still slightly different. As mentioned before the closing schemes are slightly different. Finally the data years used are different. Both use the 1977 input-output tables, but IMPLAN updates the price data to 1982 dollars, while RIMS II uses only 1977 numbers.

The authors found RIMS II multipliers to be about 6% higher than IMPLAN Type II multipliers across the thirty-five sectors. Five RIMS II multipliers are less than IMPLAN Type II multipliers, a result in conflict with theoretical expectations. The authors suggest this is the result of sectoring differences. In addition, IMPLAN Type III multipliers are higher than IMPLAN Type II multipliers in eight of the thirty-five sectors, another inconsistency with theory.

The authors conclude that the major differences in the models are in the treatment of foreign imports and the regionalizing procedures. The authors are not completely satisfied that the supply-demand pool technique is actually equivalent to the LQ techniques, and that the RPC technique is always equal to or less than supply-demand pool. As mentioned above, if these conditions always held, IMPLAN multipliers would always be lower than RIMS II. They note that differences in the aggregation schemes and the closing of the models may allow IMPLAN multipliers to be greater.

A further look at Borgen and Cooke's data reveals that the default IMPLAN Type III multipliers are greater than RIMS II in six sectors of the thirty-five, including Hotels/Lodging and Amusements and Eating and Drinking Places. Specifically, IMPLAN is respectively 1.2% and 1.0% higher than RIMS II.

The most recent and applicable comparison of ready-made input-output models that includes RIMS II and IMPLAN is by Rickman and Schwer (1995). They compare output and employment multipliers for the 1992 versions of RIMS II, IMPLAN and REMI and offer modifications for IMPLAN and REMI that induce estimates that approach RIMS II. The area for which they estimate multipliers is Clark County, Nevada. They estimate multipliers for Clark County's nine largest sectors: Amusement and Recreation, Construction, Eating and Drinking, Hotel, Medical, Miscellaneous Business Services, Miscellaneous Professional Services, Other Retail, and Real Estate. Since they looked at Eating and Drinking and Hotel multipliers this study is particularly relevant.

Concerning IMPLAN versus RIMS II, the authors note that Olson 1989 found IMPLAN Type III multipliers to be five to eighteen percent smaller than comparable standard Type II multipliers such as those used by RIMS II. They also note, however, that Borgen and Cooke (1992) found IMPLAN Type III multipliers to be larger than hand calculated IMPLAN Type II multipliers.

The authors claim that earlier comparisons are ambiguous because no attempt has been made to control for the methodological differences between models. They outline three major differences between RIMS II, IMPLAN, and REMI: (1) the models specify different closure rules; (2) they use different techniques to regionalize the national technical coefficients; (3) they use different sources of data. The authors note that the expected difference due to divergent closure rules is unknown, as is the expected difference due to data choice. Differences in regionalization technique, however, can be assumed to affect the models in a particular way. RIMS II's use of the location quotient (LQ) technique to regionalize national technical coefficients should produce larger multipliers than IMPLAN or REMI[5], all else being equal.

The authors first estimate multipliers for the off-the-shelf versions of these models. They then attempt to make the models more similar by correcting for the first two methodological differences. Differences in closure are only problematic with REMI. Two versions are created and labeled REMI2 and REMI2A. IMPLAN is then modified to correct for regionalization differences and labeled IMPLANA. In this version of IMPLAN the authors take advantage of the corrected MRIO data (Multi-Regional Policy Impact Simulation Project 1988). The corrected data is intended to lessen the gap between RIMS II's LQ method and IMPLAN's RPC method of regionalizing national coefficients. In addition IMPLANA uses the REMI procedure of multiplying the interregional trade coefficients by the 1990 supply-demand pool ratios, effectively controlling for differences in constraints on the RPC's between IMPLAN and REMI.

The results show the employment multipliers of all three default versions to be significantly correlated. IMPLAN had the largest employment multipliers for all sectors except

[5] This is because the LQ method precludes cross-hauling

Real Estate[6], while REMI consistently had the smallest. The output multipliers of the default versions mirror the employment multipliers in relative magnitude. Again, IMPLAN yields the largest multipliers in all sectors, this time excepting Miscellaneous Professional Services. The RIMS II and REMI multipliers are statistically indistinguishable and in contrast to the employment multipliers, only the RIMS II and REMI output multipliers are correlated.

The modified REMI models--REMI2 and REMI2A--yield smaller output and employment multipliers than the default REMI version. The new models' relation to RIMS II and IMPLAN remains the same. The modified version of IMPLAN—IMPLANA—produces the largest employment multipliers in five sectors and the largest output multipliers in six sectors. The IMPLANA multipliers, however, are closer to RIMS II and REMI. After reporting the results of the modified versions, the authors note that "since different data sources are used in the regionalization of the national coefficients, the theoretical effect of the differences in regionalization techniques may not strongly reveal themselves in the estimated multipliers." This cautionary note seems to imply the obvious result--different data, different results.

From the authors' tables of multipliers, I calculated percent differences between employment and output multipliers of RIMS II and IMPLAN and RIMS II and IMPLANA. IMPLAN employment multipliers are 11.6% larger on average than RIMS II multipliers. IMPLANA, on the other hand, is 1.9% smaller than RIMS II multipliers. Concerning output multipliers, IMPLAN is 24.3% larger than RIMS II and IMPLANA is 7.0% larger.

The percent difference in the two sectors, *Eating and Drinking* and *Hotel*, is probably the most relevant. IMPLAN employment multipliers are respectively 26.0% and 8.4% larger

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[6] The authors hypothesize that the large RIMS II Real Estate Multiplier is due to its use of

than RIMS II multipliers. IMPLANA is respectively 12.6% larger and 4.2% smaller than RIMS II. The percent differences in output multipliers are considerably larger. IMPLAN is 87.5% and 18.9% larger, and IMPLANA is 54.4% and 2.3% larger than RIMS II.

Unfortunately this is nearly the extent of the literature comparing RIMS II and IMPLAN. Many articles have been published comparing IMPLAN and other ready-made models, comparing RIMS II or IMPLAN to other ready-made models, comparing one of these and survey based models, and comparing other ready-made models with both other ready-made models or survey-based models. An article by Brucker, Hastings, Latham (1987) compares five ready-made models–including IMPLAN and RIMS II—but concentrates on costs and flexibility to differentiate between models. Radke, Detering, Brokken (1985) compared IMPLAN with five survey-based models for the counties in Colorado, Idaho, Nevada, Oregon, and Wyoming. As might be expected, the authors concluded that IMPLAN inaccurately calculates multipliers. In particular, IMPLAN tends to give larger multipliers than the survey-based models. There is plenty of debate concerning model comparisons. Crihfield, Harrison, and Campbell (1991) compared output impacts of REMI and IMPLAN for the opening of the Diamond-Star automobile assembly plant in Bloomington-Normal, Illinois. Grimes, Fulton, Bonardelli (1992) then disputed the methodology of comparison and conclusions of Crihfield et al. The round of debate on this single comparison continued with a reply by Crihfield et al. (1992). The main point is that the literature is extensive and so is the disagreement.

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wage and salary data, which omits the self-employed.

2.2 Measuring Economic Completeness

Economic completeness is important to the multiplier concept. The concept of economic completeness, however, is not easily discussed. Part of the problem is that the literature focuses on diversity, not completeness. The two are similar, but not exactly the same. For example, New York City has a much more diverse economy than Missoula, MT. This does not mean that Missoula is necessarily less complete than New York City. Missoula is far away from larger economies and so it must provide many goods and services for itself. In addition, many smaller nearby economies come to Missoula for many goods and services. Distance and location may make Missoula, MT as self-sufficient, and thus complete, as New York City.

In the absence of literature focusing on economic completeness, economic diversity will be used as a substitute. An economy with a wide variety of industries can purchase more of its goods and services from within itself. In other words, a more diversified economy will import less of its needs than a more specialized economy with a more narrow variety of industries. This means that a more diverse economy will have fewer "leakages" and thus a higher multiplier than a less diverse economy.

Measuring economic diversity is not a straight forward matter with universally accepted measurements. Part of the problem is that no single definition of diversity exists. The existence of multiple definitions has contributed to the ambiguity and confusion concerning economic diversity, its measures, and hypothesized relationships to economic performance (Siegal et. al 1995). A number theories are used in different contexts. These include industrial organization theory, economic base theory, regional business cycle theory, trade theory, portfolio theory, location and regional economic theories, and economic development theory[7].

2.2.1 Industrial Organization Theory

Industrial organization theory uses sectoral concentration ratios such as the ogive and entropy index to measure diversity. The entropy index is currently the most popular measure of sectoral concentration. It can be expressed as:

$$\textit{Entropy Index} = \sum_{i=1}^{N} X_i \ln X_i \qquad (2.1)$$

where X_i is the sectoral share of economic activity. A higher entropy index implies greater diversity. The entropy index achieves its maximum value, *lnN*, when employment or income is equally distributed among N sectors. This situation is referred to as "perfect diversity." There is, however, no *a priori* economic reason why a region's sectors should have equal shares. This problem is of greater concern when looking at ways of diversifying an economy over time than when simply measuring diversity at a static point in time.

2.2.2 Economic Base Theory

Economic base theory concentrates on exports. It compares a region's employment or income in a particular sector to national averages in order to derive a location quotient (LQ). A *coefficient of specialization* is then calculated by summing the sectoral LQs. The literature acknowledges the limitations of this method (Siegal et. al. 1995, Hoover and Giarratani 1985). In addition, using LQs to estimate economic

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[7] Trade theory, portfolio theory and economic development theory address ongoing diversification and stability, not simple static diversity.

diversity is no different than using correctly derived multipliers to measure economic diversity; something that IMPLAN or RIMS II could provide.

2.2.3 Regional Business Cycle Theory

Regional business cycle theory draws heavily from economic base theory. Regional business cycle theory uses a region's share of stable and unstable sectors as a measure of economic diversity. Durable goods are considered to have high short-run income elasticity, meaning that durable goods are highly sensitive (unstable) to cyclical fluctuations. From this assumption follows the idea that the higher the percent of durable goods in a region's export mix, the less economic diversity in a region. When used at all, this theory is usually applied to measure both diversity and stability.

2.2.4 Location and Regional Business Cycle Theory

Location and regional economic theories concentrate on the spatial distribution of economic activity. Economic activity tends to occur in spatial clusters. This leads to the assumption that regions with larger populations have more linkages between firms and sectors, fewer leakages, and thus greater diversity. In addition to using population size as a proxy for regional diversity a number of theories exist to address the concept of hierarchical relationships between regions. These theories include central place theory, growth pole theory, product life-cycle theory, and dependency theory. All of these theories are based on the idea that some regions are economic growth centers (or *core*) and some regions are economic hinterland (or *periphery*). Measuring diversity with any of these theories considers both the *variety* and *types* of economic activities in a region.

Unfortunately, due to the difficulty of applying these theories, they have remained mostly just theories. A study in the mid-1960's applied central place theory to urban places in the upper Midwest[8]. The study categorized trade centers into a central place hierarchy with seven levels. Figure 2-1 is a reproduction of the study's classification system (Hoover and Giarratani 1985).

Additional central place indexes are scarce to nonexistent. After extensively perusing research databases, I uncovered only two other indexes. One index for India's trades centers and one index for trades centers in Peru. Both studies are virtually irrelevant to the U.S. economy.

Although it may be possible to use the upper Midwest study as a reference for the entire U.S., this index assumes that the upper Midwest is representative of trades centers in the entire United States. This assumption may be of questionable plausibility considering the regional differences in the U.S. economy.

[8] The study was entitled *Trade Centers and Trade Areas of the Upper Midwest*, Upper Midwest Economic Study, Urban Report No.3 (Minneapolis: September 1963), John R. Borchert and Russell B. Adams.

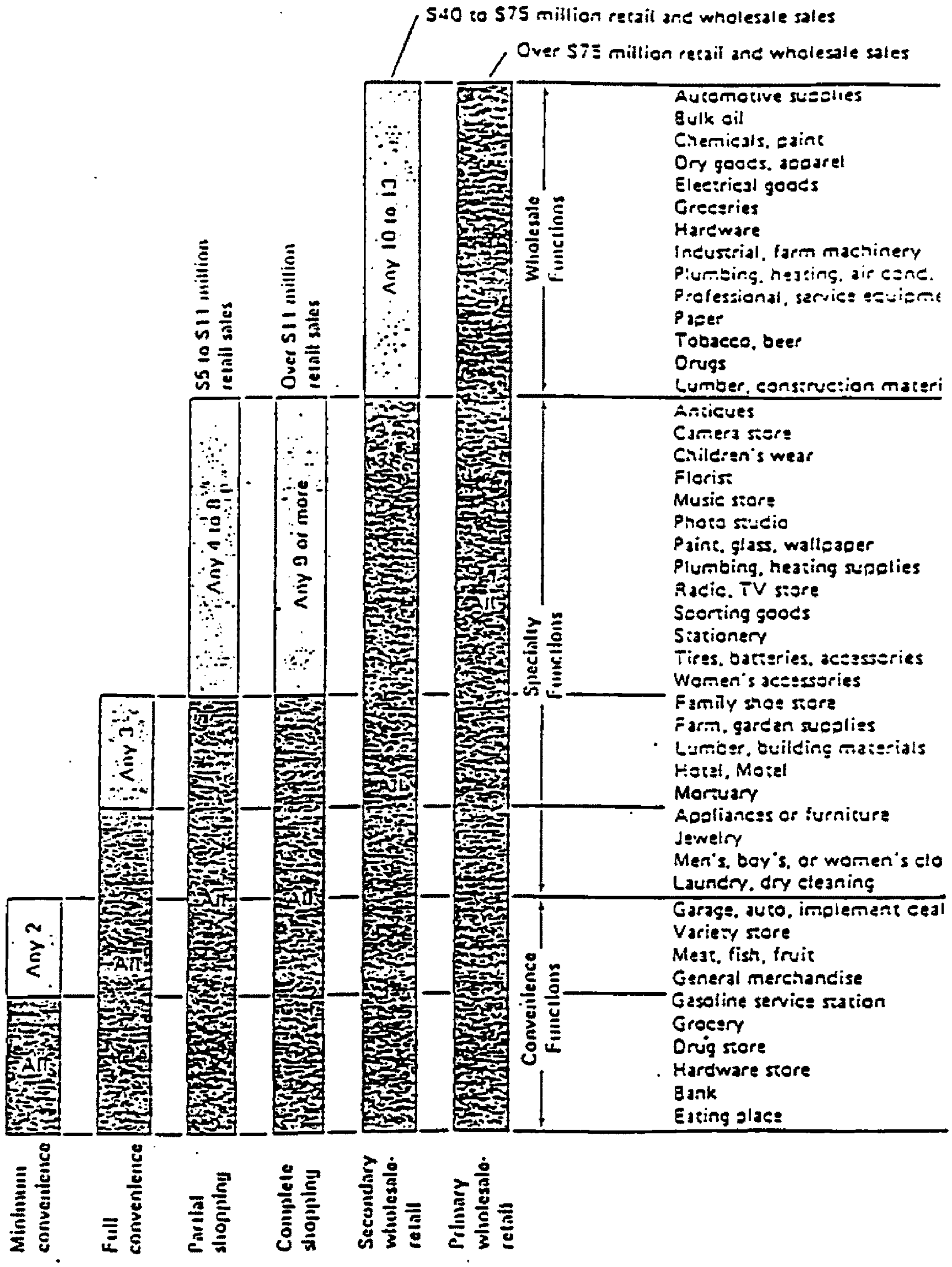

Figure 2-1: Trade Center Classification in the Upper Midwest

2.3 Evaluating Measures of Economic Diversity for Measuring Economic Completeness in MGM Analysis

The entropy measure and coefficient of specialization are closely related to crude multipliers. There is no reason to use these measurements for economic completeness when the IMPLAN multiplier does a more sophisticated and complete job of measuring completeness. Regional business cycle theory and economic base theory have their problems too. Regional business cycle theory is not as accepted in the literature, and like economic base theory from which it is derived, it requires largely subjective judgments on basic versus nonbasic sectors and durable versus nondurable sectors. Finally, while regional economic theories such as central place theory, growth pole theory, product life-cycle theory, and dependency theory offer population as a proxy for economic diversity (which will be used in analysis), they also require normative judgments of core versus periphery economies and considerable sophistication in cataloguing the variety and types of economic activities. Unfortunately, the economic diversity literature offers little in the way of standard, easily obtainable, measures for economic completeness.

Chapter 3 Methodology

3.1 Introduction

The purpose of the regression analysis is to check the rationality and validity of the informally approximated MGM multipliers. In the process a method of formally estimating an equivalent park multiplier is developed. The rationality of the informally approximated multipliers is based on theory dealing with economic diversity. It is assumed that a more diverse economy will retain more money injected from outside the community than a less diverse economy, thus yielding a larger multiplier for the more diverse economy. The IMPLAN variable is intended to test whether the informally approximated park multipliers are consistent with a standard non-survey based model, namely IMPLAN. The variables characterizing economic completeness are intended to test whether the informally adjusted park multipliers are consistent with economic theory. Finally, regressors are present to check for measurement error.

3.2 Regression #1

The RIMS II statewide multipliers are adjusted into park multipliers by Dr. Kenneth Hornback. Presumably he uses a systematic methodology in the adjustment. The following regression is designed to detect the source(s) of Dr. Hornback's adjustment procedure. Predicting the expected sign on these coefficients is difficult since one cannot know Dr. Hornback's mind. His adjustments may be systematic, but not necessarily consistent with economic theory.

To complicate matters further, most measurements of economic conditions are at the county level. The limited park level data available is associated with the city in which a park's headquarters is located. Although the headquarters maybe the only gateway community for most parks, it may not be the only gateway community; nor may there be any gateway community for some parks.

The formal structure of Regression #1 follows:

$$State^{RIMS} - Park^{RIMS} = b_0 + b_1 X_1 + b_2 X_2 + \ldots + b_9 X_9 \qquad (3.11)$$

Where:

- X_1 = State^{IMPLAN} - County^{IMPLAN}
- X_2 = % state population in county
- X_3 = % state sectors in county
- X_4 = metropolitan county dummy; 1 if metropolitan county (MSA, CMSA, NECMA), 0 otherwise
- X_5 = ratio of park headquarters community population to county population
- X_6 = rural park dummy; 1 if rural, 0 otherwise
- X_7 = metro county and rural park interaction, X_4 and X_6; 1 if X_7, 0 otherwise
- X_8 = % state square miles in county
- X_9 = number of counties accessing park

The regression is designed to test three hypotheses associated with systematic adjustment. The first hypothesis might be called the *naïve* hypothesis. It assumes that the RIMS II park multipliers are adjusted from the state multipliers in exactly the same manner as the IMPLAN county multipliers are adjusted from the state multipliers. This hypothesis implies that the study area of the park multipliers and the county multipliers is the same. For this hypothesis to be true the coefficient on the IMPLAN regressor must be exactly one and no other regressors can be significant.

The second hypothesis is the *sophisticated naïve* model. It assumes that the RIMS II and IMPLAN multipliers are conceptually equivalent and adjusted according to their respective study areas. Since the park multipliers are associated with smaller study areas than the IMPLAN county multipliers, the park multipliers should be adjusted further down from the state multipliers than the county multipliers are. This should result in a positive coefficient greater than one. As the difference between state and county IMPLAN multipliers increases, the difference between state and park RIMS II multipliers should increase.

Since the RIMS II park multipliers are based on educated judgments and not mathematical adjustment procedures, it is unlikely that the RIMS II multipliers vary in exactly the same way as the IMPLAN multipliers. It is possible that IMPLAN simply adjusts its multipliers in such a different way that the IMPLAN coefficient will not indicate a systematic adjustment in the RIMS II multipliers. In order to detect any systematic adjustment not associated with the IMPLAN adjustment technique, additional variables were applied in the regression. This allows the testing of a third hypothesis referred to as the *sophisticated* hypothesis. Like the *naïve sophisticated* hypothesis, the third hypothesis assumes that the RIMS II and IMPLAN multipliers are conceptually equivalent[9], and it also assumes that additional factors--apart from those associated with the IMPLAN adjustment--are considered by NPS in its modification procedure.

Three variables measuring economic completeness are used. They include variables for the percent of state population in a county, the percent of state sectors in a county, and a dummy variable for the Bureau of Census's classification of metropolitan and non-metropolitan counties. Higher values for these variables indicate economies that are more complete and more similar to the state economy. They should each have a

[9] So the coefficient on IMPLAN is assumed to be greater than one.

negative effect on the RIMS II state and park multiplier difference. As the economy around a park becomes more diverse, the difference between state and park multipliers should decrease.

Three variables are intended to test for a systematic adjustment process that is not necessarily based on gateway communities, but is based instead on the character of a park. The variables attempt to identify the MGM's gateway community definition. The variables included a ratio of the community population in which a park's headquarters is located to the population of the county in which it is located (i.e. community population divided by county population). This variable is intended to detect variation in park and county multipliers due to differences in gateway community and county populations. A ratio closer to one indicates that the gateway community and the county economies are more similar. As the ratio falls, the similarity between the gateway and county economies declines, and the adequacy of the IMPLAN county multiplier also declines. Part of the dependent variable, $State^{RIMS}$-$Park^{RIMS}$, is left to be picked up by this variable. The decreased similarity should result in a park multiplier that is smaller than the county multiplier and a negative sign for the population ratio coefficient.

The second variable indicating park characteristics is a dummy variable accounting for rural and urban parks. The measurement is a modified NPS classification. The assumption behind this variable is that rural parks are surrounded by rural communities with less complete economies and thus smaller multipliers. Rural parks should increase the difference between RIMS II state and park multipliers. Thus the coefficient for this regressor should be positive. As a warning, it should be noted that the rural and urban park classification does not necessarily reflect the actual economic completeness of gateway communities nor what are the gateway communities. It is a measure of how NPS may perceive the economic completeness of the economy impacted by a park. Intuitively, rural parks would seem to offer less complete economies than urban parks.

Finally, an interaction term combining the effects of a rural or urban park classification with a metropolitan or non-metropolitan county classification is intended to pick up variability due to a park being located in a rural area of an urban county and vice versa. This means that the effects of the *metropolitan county* dummy and the *rural park* dummy cannot be evaluated separately. Instead, four different scenarios must be considered if the interaction term is significant.

The first case is that of an urban park in a non-metropolitan county. This is the base case from which the other scenarios are evaluated. The interactive effect of this situation on the dependent variable is expected to be zero. Progressing in the magnitude of effects on the dependent variable, the next case is that of an urban park in a metropolitan county. In this case the park multiplier is expected to be higher than in the base case situation. However, it will not be much higher. The urban park characteristic matches the character of the county and since the variables for economic completeness are at the county level, the interaction's effect is already taken up by these variables. The third scenario is for a rural park in a nonmetropolitan county. The magnitude of this interaction is not necessarily higher than the magnitude of the second scenario. Like the previous scenario, the character of the park matches the character of the county. The direction of the effect, however, is expected to be different. A rural park in a nonmetropolitan county will have a smaller multiplier than the base case of an urban park in a nonmetropolitan county. The fourth scenario effects the dependent variable the most.

The fourth case is that of a rural park being in a metropolitan county. In this situation the character of the park does not match the character of the county. The effect of the interaction is therefore expected to be more than in the previous cases. The variables measuring county economic completeness should increase the multiplier, so that the interaction effect should be negative to counterbalance the county level variables. Since the county and park characters are dissimilar, the effects will have to be greater than in the situation when they were similar.

The expected coefficients, along with the coefficients associated with the various scenarios, are summarized below.

- If nonmetropolitan county and urban park –> then the adjustment is in the constant. ($X_4 = 0$ and $X_6 = 0$: coefficient b_1)
- If metropolitan county and urban park then the adjustment is in the metropolitan county coefficient. ($X_4 = 1$ and $X_6 = 0$: coefficient b_4, expected sign is negative)
- If nonmetropolitan county and rural park –> then the adjustment is in the rural park coefficient. ($X_4 = 0$ and $X_6 = 1$: coefficient b_6, the expected sign is positive)
- If metropolitan county and rural park –> then the adjustment is in the additive coefficients of the metropolitan county, rural park, and interaction term. ($X_4 = 1$ and $X_6 = 1$: coefficient $b4 + b6 + b7$, the expected sign is positive)

Finally, two variables measuring the square miles in a county and the number of counties accessing a park are present to detect measurement error. The physical size of the county has no theoretical bases for affecting economic completeness and thus the multiplier. It is plausible, however, that a larger county may be perceived as being more rural and less complete, or since it is larger it may even be perceived as being more complete. Finding this variable significant would raise suspicion of the validity of the park multiplier adjustment. The final variable measuring the number of adjacent counties is intended to detect measurement error due to differences in defining the impact area. A park accessed by multiple counties should have a larger multiplier yielding a smaller difference between the RIMS II state and park multiplier and thus a negative coefficient. It is possible, however, that the park multiplier only considers a single entrance to a park with two or more entrances. If this is the case then the regressor would not have a significant coefficient because the park level multiplier would consider only one gateway community, ignoring the other gateway communities.

Finding any regressors significant in addition to the IMPLAN regressor leads to the rejection of the *naïve sophisticated* hypothesis which says that the informally adjusted park multipliers only consider elements imbedded in the IMPLAN multiplier adjustment. The third hypothesis referred to as the *sophisticated* hypothesis is the only hypothesis then that is not rejected. Considering the variability between the IMPLAN and RIMS II multipliers suggested in the literature and the informal method of park multiplier derivation, this more complicated hypothesis is the most likely of the three to be true. No matter which hypothesis is true, if the IMPLAN coefficient is significant and of an expected magnitude, then the RIMS II park multipliers that the National Park System has been using follow a similar systematic logic to IMPLAN multipliers, yielding hope that the

MGM multipliers have some validity.

3.3 Regression #2

The second regression is designed to determine a method of predicting a RIMS II park multiplier that is independent of Dr. Hornback and to test whether the determinants of the park multiplier are consistent with theory.

The regression looks like Regression #1 with the differences and percentages removed. The dependent variable is the Park^{RIMS} multiplier. The independent variables include measurements of economic completeness, park characteristics, and indicators of measurement error. The variables of economic completeness include the county IMPLAN multipliers, county population, number of sectors in the county, and a dummy variable for metropolitan counties. Three variables attempt to differentiate the county from the park by measuring park characteristics. These are a ratio of park headquarters community to county population, a dummy variable for rural and urban park classification, and an interaction term combining the metropolitan and non-metropolitan county classification with the rural and urban park classification. Finally, the physical area of a county and the number of counties accessing a park are intended to detect measurement error.

$$Park^{RIMS} = b_0 + b_1 X_1 + b_2 X_2 + \ldots + b_9 X_9 \qquad (3.12)$$

Where:

- X_1 = County^{IMPLAN}
- X_2 = county population
- X_3 = number of industry sectors in county
- X_4 = dummy variable; 1 if metropolitan county (MSA, CMSA, NECMA), 0 otherwise
- X_5 = ratio of park headquarters community population to county

population

- X_6 = dummy variable; 1 if rural
- X_7 = interaction variable of X_4 and X_6; 1 if X_6, 0 otherwise
- X_8 = county square miles
- X_9 = number of counties accessing park

As with Regression #1 three hypotheses are being tested. They are essentially the same hypotheses: *naïve*, *sophisticated naïve*, and *sophisticated*. The County^{IMPLAN} regressor is intended to detect whether the Park^{RIMS} multiplier is consistent with another standard multiplier. In addition it measures economic completeness. A more complete economy has a higher multiplier than a less complete economy. Under the *naïve* hypothesis, the RIMS II park multipliers are derived in the same way as the IMPLAN county multipliers without consideration of the difference in study areas. The expected coefficient for IMPLAN is one, with no other regressors found to be significant. The *sophisticated naïve* hypothesis assumes that the multipliers are conceptually equivalent with consideration given to the differences in study areas. The IMPLAN county multiplier should be larger than the community based park multiplier implying a coefficient less than one for IMPLAN. Under this hypothesis no additional regressors should be significant. Finally, the *sophisticated* hypothesis assumes that additional information is used to derive the park multipliers apart from that in the IMPLAN county multipliers.

Under the *sophisticated* hypothesis the variables measuring economic completeness (X_2, X_3, and X_4) should be positively correlated with the dependent variable. A significant coefficient on the ratio of park headquarters community population to county population should indicate that the adjusted park multipliers do, in fact, encompass only gateway communities and not larger county areas. A positive correlation is expected. The dummy variable for rural park should have a negative coefficient. The interaction term will have the same effect on the park multiplier as outlined in the previous section. With the removal of the difference in the dependent variable, the predicted coefficients are turned around making the interaction term more intuitive.

The regressor X_9, indicating the number of counties accessing a park, should have a positive coefficient to be consistent with economic theory. A larger study area that includes a number of gateway communities should have a larger multiplier than a study area that concentrates on only one gateway community. If the coefficient is insignificant, then it would raise questions as to whether the MGM was accounting for all of the gateway communities.

The square miles in a county has no theoretical relationship to economic completeness. The coefficient could be positive or negative depending on whether NPS perceives larger counties to be more encompassing and thus more diverse—a positive correlation to the park multiplier—or whether they perceive larger counties to be more rural and thus less diverse—a negative correlation to the park multiplier. No matter what the sign on the coefficient, a significant correlation would raise questions of the validity of the RIMS II park multiplier since there is no theoretical bases for area to affect economic completeness.

The second regression is very similar to Regression #1. Regression #2, however, is much simpler. The dependent variable is simply the informally approximated park multiplier instead of a difference between two multipliers. In addition, there are no county to state ratios. This is because Regression #2 is not trying to detect the adjustment procedure from the RIMS II state multipliers. It is intended to check the multiplier's consistency with theory and to determine a method of predicting equivalent park multipliers.

This second regression, however, has three advantages over Regression #1. The first reason to perform Regression #2 is that it is a much cleaner regression. Because the previous regression uses the *differences* between multipliers, measurement error may be introduced by the independent variable ($State^{IMPLAN}$ - $County^{IMPLAN}$) which can bias the estimate. The second advantage to Regression #2 is that none of the dependent variables in Regression #1 may have been significant. It is possible that the RIMS II park multipliers have no association with the RIMS II state multipliers. Instead of considering the RIMS II state multipliers when calculating park multipliers, Dr. Hornback may have only looked at characteristics surrounding the park, such as those associated with county economics and demographics. Regression #2 is designed to pick up sources of the park multiplier even if the first regression does not. A third reason to perform Regression #2 is that rumors abound that the Bureau of Economic Analysis, the agency that maintains RIMS II, will soon discontinue offering the RIMS II statewide multipliers for free. If this happens, even if Regression #1 allows indirect estimation of the park multipliers from the state RIMS II multipliers, these multipliers may be prohibitively expensive. Finally, Dr. Hornback has very recently retired. His expertise is no longer available to determine multipliers for the parks. It was hoped that regression #2 would provide an alternative method for park multiplier derivation.

Chapter 4 Data Description

4.1 Sources

Data utilized in this thesis were primarily obtained from three sources. The RIMS II state and park multipliers and the urban/rural classifications were taken from a National Park Service document entitled "The Money Generation Model: 1995-1996." The IMPLAN multipliers came from 1993 IMPLAN data sets. 1994 data is the most current IMPLAN data available, so the data used for this analysis is almost as current as was possible at the time of analysis. Besides multipliers, three additional sets of state and county data were extracted from the IMPLAN data: 1) population 2) number of industrial sectors[10] 3) area measured in square miles. Finally, the 1994 City and County Data Book was used to determine metropolitan and non-metropolitan counties. It was also used to find the populations of the communities in which park headquarters are located. Since the City and County Data Book only includes communities greater than 2,500 people, the U.S. Bureau of Census's web page provided the populations for smaller communities.

4.2 Omitted Observations

Only the three hundred and twenty-eight parks included in the 1995-1996 MGM were considered. Twelve parks in the MGM did not have RIMS II multipliers. These parks were omitted from analysis. An additional forty-eight parks were also excluded due to various circumstances. These parks included all of Alaska's fourteen parks. Alaska's

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[10]IMPLAN has 528 sector divisions.

communities and are only accessible by plane or serious expedition. Calculating a multiplier for these parks did not make much sense, nor did comparing it to other park multipliers. The twelve parks in the District of Columbia were also omitted. This was done for two reasons: A state RIMS II multiplier was not available, and the state and study area ratios equaled one since the study area was essentially the state in this case. Three parks in the Virgin Islands, one in Guam and one in Puerto Rico were also excluded. Finally, seventeen parks were omitted due to a variety of circumstances such as inadequate data and the impossibility of defining a park study area. This left a total of two hundred sixty-eight parks for regression analysis. Table 4-1 summarizes the excluded parks.

4.3 Adjustments to the Data

To determine the study area of the parks, each park was located on a Rand McNally Road Atlas. A determination of the study area was then made according to the counties that offer road access into the park. Most parks (217) are single entrance parks. Fifty-one parks, however, provide access from more than one county. Fourteen of these parks provide access from more than one state. To calculate RIMS II state multipliers for these parks, the RIMS II state multipliers from which the park provides access were averaged. Since this was a an ad hoc method of multiplier calculation, regressions were run which included and excluded the multi-state parks.

No RIMS II Data	Insufficient IMPLAN Data	Alaska Parks	District Of Columbia Parks	Other
Hamilton Grange, NY-NJ	El Malpais, NM	Lake Clark	Ford's Theater	Virgin Islands, Vi
Hohokam Pima, AZ	Amistad TX	Aniakchak	Frederic Douglass	Buck Island Reef, Vi
Yucca House, CO	Dinosaur, UT-CO	Katmai	Lbj Mem Grove OT Potomac	Christiansted, Vi
Chesapeake And Ohio Canal, VA-MD-DC	Fort Union Trading Post, ND-MT	Gates Of The Artic	Lincoln Mem	War In The Pacific, GU
Eleanor Roosevelt, NY	Badlands, SD	Kenai Fjords	National Capital Parks	San Juan, Pr
Castle Clinton, NY-NJ	Crater Lake, OR	Cape Krusenstern	Penn Ave./Old Post Ofc	Thomas Stone, MD
National Capital Parks, DC	Big South Fork, TN-KY	Kobuk Valley	Rock Creek	Bluestone, WV
Hopewell Culture, OH		Noatak	Theo Roosevelt Island	Gauley River, WV
George Wash Mem, VA-MD		Sitka	Thomas Jefferson Memorial	Arlington House R E Lee, VA
Blue Ridge Parkway, NC-VA		Glacier Bay	Vietnam Veterans Memorial	Petersburg, VA
Palo Alto Battlefield, TX		Klondike Gold Rush	Washington Monument	Rio Grande, TX
Natchez Trace, MS-AL-TN		Yukon Charley Rivers	White House	Assateague Island, MD-VA
		Wrangell St Elias		Cumberland Gap, KN-TN-VA
		Denali		Chickamauga & Chattanooga, GA-TN
				Gulf Islands, FL-MS

Table 4-1: Parks omitted from analysis

The RIMS II multiplier that the MGM uses is an average of two multipliers offered for RIMS II by the Bureau of Economic Analysis. These multipliers are for *Hotels and Lodging Places*, sector 73.01 and *Eating and Drinking*, sector 74.00. The IMPLAN multiplier was calculated in the same manner, by averaging the individual multipliers for *Eating and Drinking*, sector 454, and *Hotels and Lodging Places*, sector 463, from IMPLAN.

When collecting population data for communities in which park headquarters are located, a handful of communities could not be found in either the City and County Data Book, nor the Bureau of Census's Internet site. It is likely that they could not be found because they are so small. In these circumstances, a population of one hundred was assigned to the nine parks for which no population measures could be found. Table 4-2 summarizes the parks assigned populations of one hundred and parks with entrances from multiple states.

Parks assigned populations of 100	**Multi-state Parks**
Pipe Spring, AZ	DEATH VALLEY, CA-NV
Tumacacori, AZ	SAINT CROIX, MN-WI
Whiskeytown, CA	GREAT SMOKY MOUNTAINS, TN-NC
Devil's Postpile, CA	GATEWAY, NY-NJ
Mese Verde, CO	SAGAMORE HILL, NY-NJ
Hovenweep, CO-UT	FEDERAL HALL, NY-NJ
Nez Perce, ID	GENERAL GRANT, NY-NJ
Petrified Forest, AZ	SAINT PAUL'S CHURCH, NY-NJ
	STATUE OF LIBERTY, NY-NJ
	THEO ROOSEVELT BPL , NY-NJ
	FIRE ISLAND, NY-NJ
	LAKE MEAD, NV-AZ
	YELLOWSTONE, MT-WY
	BIGHORN CANYON, MT-WY

Table 4-2: Parks assigned populations of 100 and multi-state parks.

The rural and urban park classification was derived from more varied measurements in the MGM. To differentiate differences in location demographics between parks, the MGM classifies parks into five categories: *rural, remote, urban, outlying,* and *suburban.* Table 4-3 describes the distribution of parks into the five categories.

	Rural	Remote	Urban	Outlying	Suburban	no label
Subtotal	**143**	**9**	**19**	**45**	**30**	**3**
Total Rural and Urban	**153**[11]		**115**[12]			

Table 4-3: Rural and Urban derivation from MGM classifications

The classification scheme does not follow any strict criteria. It is more of a loose guideline. Dr. Hornback's reply when asked about the definition and criteria of the classification scheme illustrates the point, "It's not rocket science." *Rural* in the MGM material was considered rural in my analysis, while *urban* and *suburban* were both considered urban. The assigning of the *remote* and *outlying* categories requires some explanation. The *remote* classification is for parks that are difficult to reach. These generally include islands or parks located on distant shores of lakes. After looking at which parks are considered *remote,* I classified *remote* parks as rural. *Outlying* parks are generally not quite urban and not quite suburban. For this analysis, *outlying* parks were considered urban. The MGM failed to classify three parks into any category. After

[11] Includes Kaloko-Honokahau, HI as rural.

considering each park's location and surrounding population areas, the following classifications were assigned to these parks: Monocacy National Battlefield, MD and Weir Farm, CT were classified urban, and Kaloko-Honokohau, HI was classified rural.

4.4 Data Sets and Divisions

From the two-hundred sixty-eight parks, two data sets were created for analysis. These data sets were for Regression #1 and #2. They are labeled *1A* and *2A*. These two data sets were each then broken down into three more data sets and labeled *B*, *C*, and *D*. This was done in an attempt to control for outliers and measurement error in the data. Data set *B* excludes the fourteen multi-state parks. The reason for this was the ad hoc averaging of two state multipliers to generate RIMS II multipliers for the analysis. Data set *C* omits all multi-county parks. This was done to detect measurement error due to differences in study area definitions. Finally, data set *D* excludes all parks with study areas greater than one million people. Multiplier definition for such large metropolitan areas was arguably suspicious.

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[12] Includes Monocacy, MD and Weir Farm, CT as urban.

Chapter 5 Results

5.1 Introduction

From the data two different regressions were run. They were:

Regression #1:

$$State^{RIMS} - Park^{RIMS} = b_0 + b_1X_1 + b_2X_2 + \ldots + b_9X_9 \qquad (3.11)$$

Where:

- X_1 = State^{IMPLAN} - County^{IMPLAN}
- X_2 = % state population in county
- X_3 = % state sectors in county
- X_4 = metropolitan county dummy; 1 if metropolitan county (MSA, CMSA, NECMA), 0 otherwise
- X_5 = ratio of park headquarters community population to county population
- X_6 = rural park dummy; 1 if rural, 0 otherwise
- X_7 = metro county and rural park interaction, X_4 and X_6; 1 if X_7, 0 otherwise
- X_8 = % state square miles in county
- X_9 = number of counties accessing park

Regression #2

$$Park^{RIMS} = b_0 + b_1X_1 + b_2X_2 + \ldots + b_9X_9 \qquad (3.12)$$

Where:

- X_1 = County^{IMPLAN}
- X_2 = county population
- X_3 = number of industry sectors in county
- X_4 = dummy variable; 1 if metropolitan county (MSA, CMSA, NECMA), 0 otherwise
- X_5 = park headquarters community and county population ratio
- X_6 = dummy variable; 1 if rural
- X_7 = interaction variable of X_4 and X_6; 1 if X_7, 0 otherwise
- X_8 = county square miles
- X_9 = number of counties accessing park

Recall that Regression #1 is designed to detect adjustment patterns and measurement error, while Regression #2 is intended to find a method for predicting an equivalent RIMS II park multiplier independent of Dr. Hornback.

A number of problems are associated with cross-sectional data and the ad hoc methodology utilized in the analysis. These include mutlicollinearity, heteroscedasticity, misspecification, and non-normality of errors. All eight regressions were tested for these problems and the following discussion addresses the results across all regressions.

A ninety-five percent confidence interval was used for all analysis unless otherwise specified.

5.2 Econometric Investigations

5.2.1 Mutlicollinearity

One hopes that all regressors have some correlation, however too much can cause problems such as:

1) OLS estimates with large variances and covariances
2) Wider confidence intervals leading to the acceptance of the "zero null hypothesis" more readily
3) Insignificant t-ratios
4) OLS estimates highly sensitive to small changes in data (Gujarati 1995).

Since mutlicollinearity is a problem of degree, there are no strict tests to identify when it is a problem. Following a suggestion from Gujarati (1995), zero-order correlation matrices were ran. Mutlicollinearity was identified as problematic if two regressors have a correlation greater than 0.8. In regressions *2C* and *2D*, the regressors *sector* and

IMPLAN had correlations greater than 0.8. In addition, these same regressors had correlations very close to 0.8 in regressions ***1B*** and ***1C***. Finally, *sector* and *population* were highly correlated in regression ***2D***.

Regressors	**Model**			
	1B	***1C***	***2C***	***2D***
sector/IMPLAN	-0.7890	-0.7914	0.8624	0.8468
sector/population				0.8399

Table 5-1: Highly correlated regressors

Unfortunately, mutlicollinearity has few cures. Arbitrarily dropping a regressor can cause much worse problems than it might solve. The models were left alone concerning mutlicollinearity and the reader is cautioned that mutlicollinearity might present a problem. Incidentally, multicollinearity's fourth problem listed concerning OLS estimators highly sensitive to small data changes does not appear to be present. A review of the coefficients in the ***A***, ***B***, ***C***, and ***D*** models revealed only small differences. See appendix E for correlation matrices.

5.2.2 Heteroscedasticity

The cross-sectional nature of the data prompted testing for heteroscedasticity. White's test for heteroscedasticity was used and heteroscedasticity was found in regressions ***1D***, ***2B***, ***2C*** and ***2D***. Heteroscedasticity has a number of sources. Two possible explanations include misspecification and the existence of measurement error.

Misspecification is discussed in section 5.2.5. The question of outliers is also discussed later. At this point it is worth noting that the removal of outliers served to eliminate heteroscedasticity from only one regression, ***2D***. The presence of outliers does not seem to be the only source of heteroscedasticity.

The primary consequence of heteroscedasticity is inefficiency, that is insignificant T-ratios. The insignificant T-ratios imply that the T-ratios are not valid and they cannot be trusted. White's correction was used to correct for heteroscedasticity in the relevant models. The effect of White's correction is to produce valid T-ratios. The correction showed additional significant T-ratios for the regressor *sector* (X_3) in ***1D***, ***2A***, and ***2B***, the regressor *IMPLAN* (X_1) in ***1D***, and *population* (X_2) in ***2B***. Table 5-1 summarizes the results of the corrected and uncorrected models.

MODEL	*significant at 95% level*	*significant at 90 % level*
1A	IMPLAN, population ratio, rural, outlier	
1B	IMPLAN, population ratio, rural, outlier	
1C	IMPLAN, population ratio, rural, outlier	
1D	IMPLAN^, population ratio, rural, outlier, sector^, area	
2A	IMPLAN, population ratio, area, outlier, sector^, area	rural
2B	IMPLAN, population ratio, rural, outlier, sector^, area, population^	
2C	population ratio, rural, outlier, area	
2D	population ratio, rural, outlier, area	

Table 5-1: Significant estimators
^ only significant in the corrected model

5.2.3 Outliers

It seems appropriate to discuss outliers at this point. A quick review of the graphed residuals and predicted dependent variables, revealed the existence of two serious outliers. A further teasing out of the data revealed that those two observations have error terms greater than three standard deviations from the mean. These observations are Vanderbilt Mansion towards upstate New York and Sagamore Hill in the New York City area. A review of the data for these parks revealed unusually high park RIMS II multipliers, 3.5 and 5.1 respectively. A close inspection of these parks uncovered no apparent reason for such high multipliers. The parks that surround each, such as Eleanor Roosevelt and the Home of FDR near Vanderbilt Mansion and the seven other New York City parks, have much more reasonable multipliers.

Sagamore Hill is present only in models *1A* and *2A*. Vanderbilt Mansion is present in all models. To control for problems caused by these outliers, dummy variables were created for them. This was better than simply omitting the observations because no important data was thrown out. One problem that surfaced when outlier dummies were added was that heteroscedasticity became a problem in regression *2A*. The heteroscedasticity in this model was tolerated because the problem associated with these outliers was deemed worse than the heteroscedasticity. White's correction was applied to model *2A*.

5.2.4 Jarque-Bera (JB) test of Normality

The null hypothesis of normality of the distribution of errors could not be rejected in five of the eight models. These included *1A*, *1D*, *2A*. *2B*, and *2D*. The mixed results of the JB test made it difficult to interpret across all models. The most important result of the test was that both models *1A* and *2A*, the models with the most complete data sets, showed normality of errors. It seems that the removal of observations in the remaining models may have introduced data errors due to the loss important information.

5.2.5 Ramsey's RESET test for Misspecification

Although Ramsey's RESET test has its problems, it has the advantage that it can be applied generally to any regression without knowledge of an alternative specification. The null hypothesis is no specification error. The results of the RESET test are in Table 5-3. Specification error was found in models ***1A***, ***1D***, ***2A***, ***2B***, and ***2C***. The mixed results of the RESET test were not surprising. For one, the RESET test is not an infallible test. Secondly, specification error can almost be expected when using an ad hoc regression. As stated in Chapter 3.3, the only knowledge of the source of the adjustment procedure was Dr. Hornback's professional judgment.

	1A	1B	1C	1D	2A	2B	2C	2D
Reject (Specification error)	X			X	X	X	X	
Cannot Reject (No specification error)		X	X					X

Table 5-3: Specification test results

5.3 ESTIMATOR ANALYSIS

The differences between regressions ***A***, ***B***, ***C***, and ***D*** were minimal and provide little additional insight into the multiplier analysis. To maintain clarity, only the results from regressions 1A and 2A are reported here. The results from the other regressions are available in appendix B.

5.3.1 Results for Regression #1

Variable^	Coefficient	Standard error	T-ratio
$State^{IMPLAN}$-$County^{IMPLAN}$	0.48558	0.2075	*2.340
% state population in county	-0.00084706	0.001272	-0.6657
% state sectors in county	-0.15310	0.2003	-0.7643
metropolitan county dummy	-0.061036	0.08061	-0.7572
park headquarters and county population ratio	0.10634	0.04078	*2.607
rural park dummy	0.15442	0.07227	*2.137
metro-county & rural park interaction	0.050584	0.09453	0.5351
% state square miles in county	-0.18722	0.1634	-1.146
# of counties accessing park	-0.017158	0.01588	-1.080
outlier dummy	-2.3320	0.2087	*-11.17
constant	0.16380	0.1375	1.191
r^2	0.5040		
adjusted r^2	0.4847		
sample size (n)	268		
standard error of the estimated sigma	0.28319		

Table 5-4: Regression results from model 1A
^The dependent variable is $State^{RIMS}$-$Park^{RIMS}$
*significant at the 95% level

^^H_0: Coefficient on IMPLAN = 1, $t = \dfrac{0.42698 - 1}{0.2301} = -2.49, \quad < t_c = -1.96$ on IMPLAN

Reject H_0

Recall that Regression #1 is designed to detect systematic adjustment from the RIMS II state multipliers to the RIMS II park multipliers. Three scenarios were tested with the first two being the simplest to interpret. As expected neither of the *naïve* hypotheses are supported. The *sophisticated* hypothesis is supported by finding IMPLAN and other variables significant.

Finding *IMPLAN* significant is a positive result, because, although *IMPLAN* may or may not provide more accurate multipliers than the RIMS II park multipliers, it at least follows a systematic adjustment procedure. Finding *IMPLAN* a significant variable in adjusting the RIMS II state multipliers into park multipliers gives hope that the multipliers the MGM has been using follow a systematic procedure.

In Chapter 2 the differences between the size of IMPLAN and RIMS II multipliers are discussed. On the basis of the literature one concludes that although the percent difference between IMPLAN and RIMS II multipliers is unknown, IMPLAN multipliers will most likely be larger than RIMS II multipliers. This conclusion is largely derived from the literature utilizing Type III multipliers. Cooke and Borgen's results, however, also show IMPLAN hand calculated Type II multipliers to be slightly larger. The new IMPLAN software crosses the divide between the Type II and Type III multipliers by calculating Type II multipliers leaving the expected relative size of the two multipliers ambiguous. There is no expectation that one model's multipliers should be larger or smaller than the other's.

Assuming that RIMS II and IMPLAN multipliers are conceptually equivalent, one would expect the county multipliers produced by IMPLAN to be larger than the informally adjusted RIMS II multipliers. This would lead to a coefficient greater than one for $State^{IMPLAN}$-$County^{IMPLAN}$. The coefficients on this variable, however, is only 0.49 indicating that the relative size of the RIMS II and IMPLAN multipliers is inconsistent with theory. This result is hardly a surprise considering earlier studies continually contradicted each other, sometimes showing IMPLAN multipliers to be greater and sometimes showing RIMS II multipliers to be greater, with all kinds of differences in magnitude.

Three additional regressors are significant in Regression #1. They are *park headquarters and county population ratio*, *rural park dummy*, and *outlier dummy*. Finding the population ratio variable significant would suggest that the park multipliers are, in fact, adjusted to the community level. The positive sign on this regressor, however, is counter intuitive considering that a larger headquarters should lead to a larger park multiplier and therefor a smaller state versus park multiplier differential. A larger park multiplier should reduce the difference between the RIMS II state multiplier and the park multiplier. The *rural park dummy* regressor gives more encouraging results. The coefficient on this regressor is 0.15. This makes sense. A rural park should have a smaller multiplier than an urban park. The smaller multiplier of the rural park increases the difference between the RIMS II state multiplier and park multiplier. Finally, the *outlier dummy* has a coefficient of -2.33. As mentioned earlier, no explanation can be found for the large park multipliers of these observations. Considering the large multipliers on these outliers one would expect a smaller difference between state and park multipliers yielding the negative sign on the *outlier dummy*.

One variable is conspicuously not significant. The variable accounting for the number of counties accessing a park (X_9) does not have a significant T-ratio suggesting that the MGM's park multiplier does not consider all relevant gateway communities. This situation does not reflect well on the validity of the MGM for parks accessed from multiple counties.

5.3.2 Results for Regression #2

Variable^	Coefficient	Standard error	T-ratio
$County^{IMPLAN}$	0.42897	0.1720	*2.494
county population	0.49266E-8	0.1738E-7	0.2834
sectors in county	0.00032724	0.0001418	*2.308
metropolitan county dummy	0.080675	0.08213	0.9823
park headquarters and county population ratio	-0.12092	0.02850	*-4.243
rural park dummy	-0.15024	0.08191	**-1.834
metro-county & rural park interaction	0.0034652	0.1022	0.03391
county square miles	-0.17903E-4	0.3613E-5	*-4.955
# of counties accessing park	0.020349	0.02119	0.9604
outlier dummy	2.2870	0.4774	*4.791
constant	1.1568	0.2476	*4.673
r^2	0.5554		
adjusted r^2	0.5381		
n or population	268		
standard error of the estimated sigma	0.27960		

Table 5-5: Regression results from model 2A
^The dependent variable is $County^{RIMS}$
*significant at the 95% level
**significant at the 90% level

H_0: Coefficient on IMPLAN = 1, $t = \frac{0.42897 - 1}{0.172} = -3.32, \quad < t_c = -1.96$ on IMPLAN

Reject H_0

The second regression is intended to find a method of predicting an equivalent RIMS II park multiplier. This has especial significance since Dr. Hornback has retired this year and there are rumors that the Bureau of Economic Analysis may discontinue offering RIMS II state multipliers free of charge.

Recall that Regression #2 is simpler than Regression #1. Excepting *park headquarters and county population ratio* no percentages or differences are present in this regression. Once again, the two *naïve* hypothesis are rejected leaving only the *sophisticated* hypothesis that assumes multiple factors are considered in the park multiplier derivation. The simplicity of Regression #2 increases the number of regressors with significant t-ratios. Variables with significant t-ratios include: *IMPLAN*, *sectors in county*, *park headquarters and county population ratio*, *rural park dummy*, *county square miles*, and *outlier dummy*. The regressor for *number of counties accessing park* is still not significant, casting doubt on the validity of the MGM multipliers for parks accessed from multiple counties.

The coefficients for *IMPLAN*, *sectors in county*, and *rural park dummy* all have the expected sign. A higher IMPLAN county multiplier implies a higher park multiplier. More sectors in an economy leads to a higher park multiplier. And a more rural park yields a lower park multiplier.

The coefficient for *park headquarters and county population ratio* is again puzzling. Although finding it significant reflects well on the MGM's claim that its multipliers are at the community level, the negative sign on this coefficient is counter intuitive. In addition, the *outlier dummy* is difficult to explain. Its positive sign is consistent with the unusually large multipliers of the outliers, but why these two parks have such high RIMS II park multipliers is still unknown.

Finding the regressor *county square miles* significant offers an opportunity for theorizing. It makes little theoretical sense for the physical size of a county to affect the completeness of an economy and thus the multiplier for a park. Yet, at -4.96 the t-ratio for this regressor shows high significance. The coefficient is negative implying that the smaller a county appears on a map, the larger a park multiplier is. Two possibilities for the significance and sign of this regressor come to mind. One is that Dr. Hornback looks at a map and is heavily influenced by the geographical area around a park interpreting large spaces to mean "rural." This does not reflect well on the validity of the MGM multipliers. Another possibility is that places in the country that are older and have smaller counties also have more people, more industries, and more complete economies. Counties in the western United States, for example, are relatively new, often have relatively young economies with few sectors, and simply have more land mass.

5.4 Predicting multipliers

The issue of goodness of fit needs to be addressed when evaluating the ability of Regression #2 to predict equivalent RIMS II multipliers. The usual measure of goodness to fit is the R^2 value. The R^2 value for Regression #2 is 0.5554 which says that approximately 56% of the variation in RIMS II park multipliers is explained by the variation in these variables. This is a relatively high R^2 for cross-sectional analysis. Although this may be a satisfactory indicator that the model has some predictive power for equivalent park multipliers, a further demonstration of its predicting power was employed.

Out of sample prediction was used to check the model's goodness of fit. Ninety percent of the population was sampled and regressed yielding coefficients for predicting park multipliers for the unsampled park units. Park multipliers were then estimated and graphed against the true RIMS II park multipliers. The following graph presents an encouraging picture:

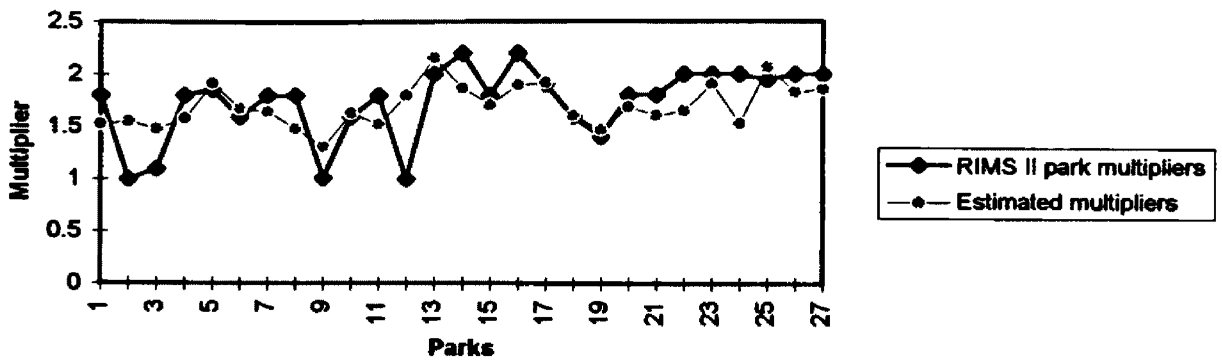


Figure 5-1: Out of Sample Prediction with Model 2A

The RIMS II park multipliers appear to have more variability than the estimated park multipliers. This is not surprising considering the estimated multipliers follow a structured methodology.

In addition to the out of sample prediction, two tailed T-tests were run against the estimated multipliers and the actual MGM park multipliers. T-tests that assumed equal variances and unequal variances were run. Both showed insignificant T-ratios indicating that the park multipliers estimated from the Regression #2 model and the MGM park multipliers are not statistically different.

5.5 Impact Estimation

To compare the differences in estimated total expenditures associated with various multipliers, the MGM was run again. Total expenditures were calculated with three different multipliers using the 1995-1996 MGM's measurements for percent nonlocal, RVD volume, and average expenditure. The three multipliers used to compare estimated total expenditures include the NPS's informally approximated multiplier, the IMPLAN county multiplier, and the estimated multiplier based on Regression #2.

Appendix D graphs the impacts using the three multipliers. Total expenditures are measured on the vertical axis with each number along the horizontal access representing a different park. The results were divided into three graphs so the parks with smaller total expenditures were not lost alongside the parks with very large total expenditures. In addition, total expenditures were sorted according to the model with informally approximated multipliers causing expenditures calculated with these multipliers to appear smoother.

Total expenditures estimated with the IMPLAN *county* multiplier are consistently lower than estimated expenditures with either of the park *community multipliers.* Although this result is interesting, it is not too worrisome, since one multiplier cannot be proven to be better than another. Of greater interest is that the expenditure estimates tend to follow each other. Although the estimates increase with increasing difference, they still increase together. Adjusting the multiplier does not seem to cause any surprises in the MGM estimates.

Chapter 6 Conclusion

6.1 Overall Conclusions

The results of the regression analysis are encouraging. The multiplier that the National Park Service uses in its Money Generation Model is similar to IMPLAN. This is promising considering that the IMPLAN multipliers are considered a standard in the field of regional impact analysis. The similarity to IMPLAN multipliers does not confirm the accuracy of the MGM multipliers, since there is no reference point for either, but the similarity at least shows that the MGM multipliers are consistent with the systematic analysis that lies behind the IMPLAN multipliers.

The significance of the other variables is not as reassuring. The sign on the *park headquarters and county population ratio* raises suspicion about the MGM multipliers. This coefficient, however, is difficult to interpret. The appropriate sign on the *rural park dummy* partly offsets the suspicion raised by the *headquarters ratio* variable. However, finding *county area* significant casts doubt again on the MGM multipliers. Overall, the regressions both raise questions and yield reassurance concerning the validity of the MGM's multipliers.

The graphed out of sample prediction results and the T-tests offer hope that Regression #2 can be used as a substitute to Dr. Hornback's judgment. The National Park Service may be able to continue obtaining consistent results with the MGM even though Dr. Hornback has retired.

6.2 Directions for Future Research

Simply because the multipliers look hopeful does not improve the overall performance of the MGM. A plethora of problems still exist. The multiplier question may even be the least of the MGM's problems. The possible problems with the MGM's remaining three elements—percent nonlocal, recreation visitor day volume, and daily expenditures—may overshadow the problems with the multiplier (refer to Table 1-1 for details of the problems associated with these elements). The possible inaccuracies in these three elements are extensive and possibly severe. Correcting for problems in these elements may not yield such similar results as a multiplier correction. Research into the accuracy of these elements is sorely needed.

In addition, the literature of prepackaged regional impact models lacks clean consistent analysis. Research comparing state, county, and local multipliers is needed. Also, the literature has not kept up with changes in software. No literature is available comparing the latest version of IMPLAN with other ready-made models.

Finally, research addressing economic completeness and diversity needs to be performed. The literature abounds in growth models, but few researchers have attempted to define levels of diversity or completeness. Models such as central place theory have attempted to deal with this issue, but empirical applications are few to non-existent. Empirical methods of measuring economic completeness and diversity are needed.

Appendix A. Park Information

Park	RIMS II park multiplier	IMPLAN county multiplier	county population	sectors in county	metro county = 1	headquarters population	rural park = 1	county square miles	# of counties accessing park
Russell Cave	1.8	1.2695	49400	150	0	2936	1	1079	1
Tuskegee Institute	1.98	1.2015	24600	108	0	12257	1	611	1
Horseshoe Bend	1.8	1.389	39400	127	0	2334	1	718	1
Canyon De Chelly	1.4	1.313	64100	111	0	5059	1	11206	1
Hubbell Trading Post	1.1	1.313	64100	111	0	1257	1	11206	1
Coronado	1.4	1.4245	103200	154	0	1762	1	6170	1
Pipe Spring	1.1	1.4845	105200	171	0	100	1	18619	1
Sunset Crater	1.4	1.4845	105200	171	0	45857	1	18619	1
Walnut Canyon	1	1.4845	105200	171	0	45857	1	18619	1
Wupatki	1.4	1.4845	105200	171	0	45857	1	18519	1
Glen Canyon	1.4	1.4845	105200	171	0	6598	1	18619	1
Tonto	2	1.3165	43500	126	0	65	1	4768	1
Chiricahua	1.8	1.3275	28500	111	0	3122	1	4630	1
Fort Bowie	1.6	1.3275	28500	111	0	3122	1	4630	1
Organ Pipe Cactus	1.4	1.5865	709900	307	1	2919	1	9187	1
Saguaro	1.4	1.5865	709900	307	0	405390	0	9187	1
Casa Grande	1.8	1.3245	123300	175	1	6927	1	5370	1
Tumacacori	1.8	1.3985	33900	128	0	100	1	1238	1
Montezuma Castle	1.4	1.507	122100	186	0	6243	1	8124	1
Tuzigoot	1.8	1.507	122100	186	0	6243	1	8124	1
Arkansas Post	1.6	1.361	21300	113	0	883	1	989	1
Pea Ridge	1.8	1.4925	110700	209	1	1620	1	843	1
Hot Springs	2.2	1.53	77800	165	0	32462	0	678	1
Fort Smith	1.8	1.563	103000	218	1	72798	0	536	1
Eugene O'neill	2	1.665	853500	326	1	313306	0	720	1
John Muir	2.3	1.665	853500	326	1	31808	0	720	1
Redwood	1.8	1.431	26800	105	0	4380	1	1008	1
Muir Woods	2.32	1.637	234500	241	1	13038	1	520	1
Point Reyes	2.32	1.637	234500	241	1	951	0	520	1
Pinnacles	1.8	1.3935	39700	151	0	636	1	1389	1
Joshua Tree	2.3	1.7245	1546000	391	1	11821	1	20062	1
Cabrillo	2.32	1.6895	2611900	403	1	1110549	0	4204	1
Fort Point	2.32	1.568	732800	308	1	723959	0	47	1
San Francisco Maritime	2.32	1.568	732800	308	1	723959	0	47	1
Whiskeytown	1.8	1.637	158800	204	1	100	1	3786	1
Devil's Postpile	1	1.553	338200	234	1	100	1	4824	1
Channel Islands	2.32	1.7195	693200	338	1	92575	0	1846	1

Great Sand Dunes	1.4	1.395	13900	103	0	399	1	723	1
Colorado	1.5	1.608	100700	190	0	4045	1	3328	1
Mesa Verde	1.6	1.388	20200	134	0	100	1	2037	1
Hovenweep	1.2	1.388	20200	134	0	100	1	2037	1
Black Canyon Ot Gunnison	1.5	1.463	26500	140	0	8854	1	2241	1
Bent's Old Fort	1.5	1.383	20300	119	0	7637	1	1263	1
Florissant Fossil Beds	1.5	1.2845	15000	108	0	2480	1	557	1
Weir Farm	2	1.6245	828800	351	1	15989	0	626	1
Fort Washington Park	2	1.419	579100	234	1	606900	0	61	1
Piscataway	1.97	1.419	579100	234	1	606900	0	61	1
Canaveral	1.95	1.48	435800	241	1	32796	0	1018	1
Big Cypress	1.8	1.5665	170700	181	1	1257	1	2025	1
Biscayne	1.8	1.7345	2003100	397	1	26866	1	1944	1
Fort Caroline	1.95	1.6395	702600	307	1	635230	0	774	1
Timucuan Ecological & Hist	1.95	1.6395	702600	307	1	635230	0	774	1
De Soto	1.8	1.519	22400	217	1	43779	0	741	1
Dry Tortugas	1.8	1.5075	82400	143	0	24832	1	997	1
Castillo De San Marcos	1.8	1.3915	94500	148	1	11692	0	609	1
Fort Matanzas	1.8	1.3915	94500	148	1	11692	0	609	1
Ocmulgee	1.6	1.5745	154000	193	1	106612	0	250	1
Cumberland Island	1.6	1.29	39800	112	0	8187	0	630	1
Fort Pulaski	2	1.624	223900	199	1	137560	0	440	1
Kennesaw Mountain	2	1.6105	495400	290	1	8936	0	340	1
Martin Luther King, Jr.	2.22	1.618	676700	329	1	394017	0	529	1
Fort Frederica	1.8	1.487	64800	150	0	12026	1	422	1
Andersonville	2	1.4095	31200	139	0	1145	1	485	1
Jimmy Carter	1.6	1.4095	31200	139	0	1218	1	485	1
Hawaii Volcanoes	2.4	1.4195	133100	165	0	91	1	4028	1
Kaloko-Honokohau	1.8	1.4195	133100	165	0	19616	1	4028	1
Pu'uhonua O Honaunau	1.86	1.4195	133100	165	0	1583	1	4028	1
Puukohola Heiau	1.8	1.4195	133100	165	0	9140	1	4028	1
Uss Arizona	1.86	1.491	866500	257	1	365272	0	600	1
Haleakala	2.4	1.3705	110800	163	0	5405	1	1159	1
Craters Of The Moon	1.4	1.1385	3000	80	0	1823	1	2233	1
Nez Perce	1.2	1.4535	35700	151	0	100	1	849	1
City Of Rocks	1.1	1.567	5700	172	0	27591	1	1925	1
Lincoln	2	1.5955	182800	201	1	105227	0	868	1

Home									
Geo Rogers Clark	1.8	1.426	40100	136	0	24365	1	516	1
Indiana Dunes	2.2	1.4015	136300	176	1	3118	0	418	1
Lincoln Boyhood	1.6	1.265	40100	121	0	233	1	516	1
Effigy Mounds	1.6	1.3905	14000	115	0	284	1	640	1
Herbert Hoover	1.8	1.285	17500	111	0	1908	1	580	1
Fort Scott	1.6	1.37	14900	119	0	8362	1	637	1
Fort Larned	1.4	1.263	7800	98	0	4490	1	754	1
Mammoth Cave	1.8	1.2115	10400	94	0	1354	1	303	1
Abraham Lincoln Birthplace	1.8	1.2275	12200	95	0	2721	1	263	1
Jean Lafitte Nhp & Pres	2.2	1.5585	487300	236	1	496938	0	181	1
Hampton	2	1.626	708000	288	1	49445	0	599	1
Catoctin Mountain	2	1.584	165900	179	1	3398	1	663	1
Clara Barton	2	1.5915	755700	233	1	234	0	486	1
Greenbelt Park	2	1.5915	755700	233	1	21096	0	486	1
Antietam	2	1.564	126000	185	1	659	1	458	1
Monocacy	1.97	1.564	126000	185	1	40148	0	458	1
Fort Mchenry	2	1.5605	715300	282	1	736014	0	81	1
Cape Cod	1.945	1.598	192900	192	1	2300	1	396	1
Salem Maritime	1.945	1.6475	674200	321	1	38091	0	498	1
Saugus Iron Works	1.945	1.6475	674200	321	1	25549	0	498	1
Springfield Armory	1.95	1.6225	449600	308	1	156983	0	619	1
Longfellow	1.945	1.5965	139800	387	1	95802	0	824	1
Lowell	1.945	1.5965	139800	387	1	103439	0	824	1
Minute Man	1.945	1.5965	139800	387	1	17076	0	824	1
Adams	1.945	1.69	626500	310	1	84985	0	400	1
Frederic Law Olmsted	1.945	1.69	626500	310	1	54718	0	400	1
John Fitzgerald Kennedy	1.945	1.69	626500	310	1	54718	0	400	1
Boston	1.945	1.542	637300	267	1	574283	0	59	1
Boston African American	1.945	1.542	637300	267	1	574283	0	59	1
Pictured Rocks	1.8	1.2725	9800	92	0	2783	1	918	1
Isle Royale	1.4	1.43	36100	131	0	7498	1	1012	1
Grand Portage	1.2	1.28	4300	77	0	1171	1	1451	1
Voyageurs	2	1.3805	16200	111	0	8325	1	3102	1
Pipestone	1.6	1.326	10400	101	0	4554	1	466	1
Natchez	1.8	1.418	34800	135	0	19460	0	460	1

Vicksburg	2	1.392	48400	1374	0	20908	0	587	1
Ozark	2	1.243	4900	84	0	1211	1	508	1
Wilson's Creek	2	1.79	218600	245	1	6292	1	675	1
Harry S Truman	2.2	1.734	633600	314	1	112301	0	605	1
Geo Washington Carver	1.8	1.4485	46300	149	1	775	1	626	1
Jefferson Nat Exp Mem	2	1.6475	3766300	301	1	396685	0	62	1
Ulysses S. Grant	2	1.6475	376300	301	1	396685	0	62	1
Big Hole	1	1.3995	8700	106	0	224	1	5543	1
Little Bighorn Battlefield	1	1.293	11800	92	0	1446	1	4995	1
Grant-Kohrs Ranch	1.8	1.2625	6800	93	0	3378	1	2326	1
Homestead	1.6	1.3875	22800	120	0	12345	1	855	1
Agate Fossil Beds	1.2	1.5245	36700	140	0	7946	1	739	1
Scotts Bluff	1.4	1.5245	36700	140	0	7946	1	739	1
Great Basin	1	1.3345	9400	98	0	337	1	8877	1
Saint-Gaudens	1.8	1.396	38400	171	0	1659	1	537	1
Edison	2.14	1.5275	770400	347	1	39103	0	126	1
Morristown	2.146	1.537	432400	292	1	16189	1	469	1
Petroglyph	1.1	1.623	506700	297	1	384736	1	1166	1
Carlsbad Caverns	1.8	1.4005	52200	134	0	24952	1	4182	1
Gila Cliff Dwellings	1.1	1.359	28500	120	0	10683	1	3966	1
Fort Union	1.1	1.2465	900	64	0	62	1	2125	1
Bandelier	1.1	1.2325	18400	90	1	11455	1	109	1
White Sands	1.1	1.386	52800	136	0	27596	1	6627	1
Aztec Ruins	1.1	1.461	97100	165	0	5479	1	5514	1
Salinas Pueblo Missions	1.1	1.303	11400	94	0	926	1	3345	1
Capulin Volcano	1.1	1.276	4100	84	0	62	1	3830	1
Martin Van Buren	1.998	1.432	63400	175	0	8112	0	636	1
Home Of Fdr	1.998	1.538	262900	215	0	21230	0	802	1
Vanderbilt Mansion	3.5	1.538	262900	215	0	21230	0	802	1
Theo Roosevelt Inaugural	1.998	1.693	970800	362	1	328123	0	1045	1
Fort Stanwix	1.998	1.549	250800	245	1	44350	0	1213	1
Saratoga	1.998	1.481	190100	186	1	7233	0	812	1
Women's Rights	2	1.3295	32800	135	0	9384	0	325	1
Upper Delaware	2	1.48	70900	155	0	11060	0	970	1
Cape Lookout	1.8	1.4155	55600	142	0	6046	1	531	1
Fort Raleigh	2	1.401	24300	105	0	991	1	382	1

Wright Brothers	1.8	1.401	24300	105	0	991	1	382	1
Guilford Courthouse	1.5	1.5985	362500	303	1	183521	0	650	1
Carl Sandburg Home	1.8	1.4475	73500	178	0	4240	0	374	1
Moores Creek	1.8	1.2905	32500	115	0	2094	1	871	1
Knife Riv Indian Vill	1.33	1.253	9400	97	0	517	1	1045	1
William Howard Taft	2	1.6785	871000	367	1	364040	0	407	1
Perry's Vict & Ipm Nm	2	1.393	40200	147	0	518	0	255	1
Chickasaw	1.6	1.302	12000	103	0	4824	0	418	1
Fort Clatsop	1.5	1.47	34600	138	0	10069	1	827	1
Oregon Caves	1.8	1.5385	67400	182	0	6217	1	1640	1
Eisenhower	2	1.4275	82500	178	0	7025	0	520	1
Gettysburg	2.2	1.4275	82500	178	0	7025	0	520	1
Johnstown Flood	2	1.6165	161600	191	1	3284	0	688	1
Valley Forge	2	1.644	392500	325	1	1500	0	756	1
Fort Necessity	1.8	1.542	146600	189	1	3296	1	790	1
Friendship Hill	1.8	1.542	146600	189	1	3296	1	790	1
Steamtown	2	1.708	217000	250	1	81805	0	459	1
Edgar Allen Poe	2	1.667	1539200	348	1	1585577	0	135	1
Independence	2	1.667	1539200	348	1	1585577	0	135	1
Thaddius Kosciuszko	2	1.667	1539200	348	1	1585577	0	135	1
Delaware Water Gap	2.14	1.3345	34100	121	1	5512	0	547	1
Roger Williams	1.77	1.5145	588000	326	1	160728	0	413	1
Fort Sumter	2	1.4925	298700	216	1	1623	0	917	1
Ninty Six	1.2	1.389	61000	155	0	2099	0	456	1
Congaree Swamp	1.2	1.446	297700	221	1	6812	0	757	1
Cowpens	1.6	1.4465	234700	266	1	1280	0	811	1
Jewell Cave	1.2	1.3095	6400	97	1	1741	1	1558	1
Andrew Johnson	1.4	1.399	57600	167	0	13532	1	622	1
Shiloh	1.4	1.332	24000	126	0	438	1	578	1
Stones River	1.6	1.468	134800	202	1	44922	0	619	1
Fort Donnelson	1.8	1.21	10200	86	0	1341	1	458	1
San Antonio Missions	2	1.726	1256400	337	1	935933	0	1247	1
Lyndon B. Johnson	1.6	1.305	6800	93	0	932	1	711	1
Big Bend	1.4	1.342	8600	100	0	249	1	6193	1
Chamizal	2	1.6335	646900	273	1	515342	0	1013	1
Big Thicket	1.2	1.3465	44600	126	1	114323	0	894	1
Guadalupe Mountains	1.6	1.195	3000	67	0	317	1	4571	1

Alibates Flint Quarries	1.2	1.2725	25200	114	0	2335	0	887	1
Lake Meredith	2.2	1.2725	25200	114	0	2335	0	887	1
Fort Davis	1.6	1.279	2000	64	0	1607	1	2265	1
Padre Islands	2	1.646	305500	214	1	257453	1	836	1
Golden Spike	1.2	1.2745	38000	143	0	15644	1	5724	1
Bryce Canyon	1.4	1.272	4000	83	0	958	1	5175	1
Arches	1.4	1.3575	7400	102	0	3971	1	3682	1
Canyonlands	1.4	1.3575	7400	102	0	3971	1	3682	1
Cedar Breaks	1.2	1.4555	23300	127	0	13443	1	3299	1
Natural Bridges	1.4	1.381	13100	98	0	125	1	7821	1
Timpanogos Cave	2	1.5435	283400	261	1	15696	0	1998	1
Zion	1.4	1.5125	59600	156	0	275	1	2427	1
Appomattox Court House	2	1.2635	12600	103	0	1707	0	334	1
Booker T Washington	1.8	1.2605	50100	142	1	5955	1	755	1
Wolf Trap Farm Park	2.2	1.5075	870300	218	1	14852	0	396	1
Colonial	2	1.298	38300	128	1	3216	0	143	1
Prince Will'm Forest Park	1.9	1.454	233700	160	1	4740	0	338	1
Fredericksbg & Spotsyl Co	2	1.369	73300	119	1	19027	0	270	1
Geo Washington Birthplace	1.8	1.2625	16100	101	0	6864	1	229	1
Manassas	1.9	1.419	30900	147	1	27957	0	10	1
Maggie L Walker	2	1.525	202000	208	1	203056	0	60	1
Lake Chelan	1.8	1.475	55100	166	0	124	1	2922	1
Fort Vancouver	1.8	1.594	271300	268	1	46380	0	628	1
Klondike Gold Rush	2	1.6575	1578000	407	1	516259	0	2126	1
Mount Rainier	2	1.6415	631900	283	1	339	0	16676	1
San Juan Island	1.8	1.3875	11200	124	0	1492	1	175	1
Ross Lake	1.8	1.4825	51700	155	0	6031	1	1270	1
Whitman Mission	1.6	1.4825	51700	155	0	26478	1	1270	1
Harper's Ferry	2	1.2865	38200	127	1	8676	0	210	1
Apostle Islands	1.8	1.301	14500	108	0	686	1	1476	1
Devils Tower	1	1.2505	5400	84	0	119	1	2859	1
Fort Laramie	1.8	1.3035	12600	116	0	243	1	2225	1
Fossil Butte	1.2	1.349	13200	113	0	3020	1	4069	1
Grand Teton	2.2	1.413	12800	122	0	519	1	4008	1
John D. Rockefeller, Jr.	1.6	1.37845	12800	122	0	519	1	4008	1
Rocky Mountain	2.2	1.542	213700	259	1	3184	0	451	2

Curecanti	1.6	1.4575	37800	154	0	4636	1	5480	2
Kings Canyon	2.2	1.5495	356600	245	1	2245	1	15016	2
Sequoia	2	1.5495	356600	245	1	2245	1	15016	2
Lassen Volcanic	2	1.629	211000	221	1	172	1	6737	2
Lava Beds	2	1.45	53500	151	0	1010	1	10231	2
Yosemite	2	1.3855	25600	123	0	1756	1	4495	2
Santa Monica Mountains	2.32	1.7355	9827500	490	1	20390	0	5906	2
Death Valley	1.01	1.341	38700	135	1	440	1	28339	2
New River Gorge	1.8	1.4645	91900	142	0	800	1	968	2
North Cascades	1.8	1.596	141200	229	0	6031	1	3005	2
Richmond	1.9	1.58	428300	271	1	203056	0	298	2
Capitol Reef	1.1	1.342	6200	102	0	436	1	7635	2
Obed	1.6	1.429	55900	161	0	932	1	1204	2
Mount Rushmore	1.4	1.5905	92300	192	1	232	1	4334	2
Wind Cave	1.2	1.3485	13500	113	0	4325	1	3298	2
Kings Mountain	1.8	1.4555	185200	241	1	8763	1	1076	2
Hopewell Furnace	1.8	1.7345	738100	377	1	470	0	1615	2
Allegheny Port Rr	1.8	1.679	293400	238	1	3284	0	1214	2
John Day Fossil Beds	1.6	1.3085	9400	103	0	4919	1	6244	2
Navajo	1.4	1.49	189300	191	0	158	1	28573	2
Grand Canyon	1.1	1.522	216200	223	1	1499	1	31931	2
Petrified Forest	1.4	1.4015	148200	150	0	100	1	21160	2
Cuyahoga Valley	2	1.675	1933400	419	1	11818	0	871	2
Theo Roosevelt	1.2	1.301	7100	99	0	101	1	3893	2
Cape Hatteras	1.8	1.4015	29700	123	0	6046	1	995	2
Pecos	1.1	1.5705	135500	203	1	3452	0	6626	2
Chaco Culture	1.1	1.424	91500	148	0	5479	1	10166	2
El Morro	1.1	1.431	88700	145	0	517	1	989	2
Lake Mead	2	1.586	990000	304	1	12567	0	21223	2
Glacier	2	1.551	77500	181	0	300	1	8094	2
Sleeping Bear Dunes	1.8	1.3355	30700	140	1	355	1	669	2
Acadia	1.784	1.4525	85500	185	0	4443	1	1955	2
Everglades	2.1	1.738	2173800	400	1	26866	0	3969	2
Yellowstone	1.8	1.4215	95700	210	0	443	1	12106	3
Olympic	1.8	1.477	150400	211	0	17710	1	5471	3
Bighorn Canyon	1.8	1.358	31100	139	0	100	1	10180	3
Chattahooche e River	2	1.6875	1741000	407	1	26302	0	1137	3
Saint Croix	1.8	1.5425	258500	241	1	1640	0	3138	4
Coulee Dam	1.6	1.348	86100	161	0	1087	1	12261	4

Great Smoky Mountains	2.4	1.479	183500	224	1	3417	0	2105	4
Shenandoah	1.9	1.423	130400	191	1	4587	1	1800	5
Buffalo	2	1.4645	91900	183	0	9922	1	3233	5
Gateway	1.998	1.597	8880000	460	1	7322564	0	2149	8
Sagamore Hill	5.1	1.597	8880000	460	1	7322564	0	2149	8
Federal Hall	1.998	1.597	8880000	460	1	7322564	0	2149	8
General Grant	1.998	1.597	8880000	460	1	7322564	0	2149	8
Saint Paul's Church	1.998	1.597	8880000	460	1	7322564	0	2149	8
Statue Of Liberty	2.1	1.597	8880000	460	1	7322564	0	2149	8
Theo Roosevelt Bpl	1.998	1.597	8880000	460	1	7322564	0	2149	8
Fire Island	1.998	1.6255	10223000	464	1	40962	0	3060	9

Appendix B. SHAZAM Program for Model *2A*

```
read(data1a.txt) id y implan pop sector metro popratio rural inter area coun
sample 2 269
stat / all anova

******************************INCLUDING THE OUTLIERS AS DUMMIES

GEN D=0
IF (ID.EQ.169) D=1
IF (ID.EQ.300) D=1

ols y implan pop sector metro popratio rural inter area coun D / &
predict=yhat resid=e LM

diagnos / RESET

****************************White's test for Heteroscedasticity
gen e2=e*e

gen implan2=implan*implan
gen pop2=pop*pop
gen sector2=sector*sector
gen poprat2=popratio*popratio
gen area2=area*area
gen coun2=coun*coun

gen implpop=implan*pop
```

```
gen implsect=implan*sector
gen implmetr=implan*metro
gen implpopr=implan*popratio
gen implinte=implan*inter
gen implarea=implan*area
gen implcoun=implan*coun
gen implrura=implan*rural

gen sectmetr=sector*metro
gen sectpopr=sector*popratio
gen sectrura=sector*rural
gen sectinte=sector*inter
gen sectarea=sector*area
gen sectcoun=sector*coun

gen metropop=metro*popratio
gen metroint=metro*inter
gen metroare=metro*area
gen metrocou=metro*coun

gen popratru=popratio*rural
gen popratin=popratio*inter
gen popratar=popratio*area
gen popratco=popratio*coun

gen ruralint=rural*inter
gen ruralare=rural*area
gen ruralcou=rural*coun

gen areacoun=area*coun

gen popsect=pop*sector
gen popmetro=pop*metro
gen poppopra=pop*popratio
gen poprural=pop*rural
gen popinter=pop*inter
gen poparea=pop*area
gen popcoun=pop*coun

gen Dimplan=d*implan
gen Dpop=D*pop

ols e2 implan pop sector metro popratio rural inter area coun implan2 pop2 &
sector2 poprat2 area2 coun2 implpop implsect implmetr implpopr &
implrura implinte implarea implcoun popsect popmetro poppopra &
poprural popinter poparea popcoun sectmetr sectpopr sectrura &
```

```
sectinte sectarea sectcoun metropop metroare metrocou &
popratru popratin popratar popratco ruralare &
dimplan dpop ruralcoun areacoun

stop
```

Appendix C. SHAZAM Regression Output

C.1 Model *1A**

Variable Name	Estimated Coefficient	Standard Error	T-ratio 208 DF	P-value	Partial Correlation.	Expected Sign	Elasticity at Means
IMPLAN[13]	0.42698	0.2301	1.855	0.968	0.121	+, > 1	0.4329
POP	-6.99E-04	1.32E-03	-0.5277	0.299	-0.035	(-)	-0.005
SECTOR	-0.21538	0.2133	-1.01	0.157	-0.066	(-)	-0.373
METRO	-8.95E-02	8.88E-02	-1.008	0.157	-0.66	(-)	-0.1633
POPRATIO	0.13169	6.14E-02	2.143	0.983	0.14	(-)	0.1272
RURAL	0.11702	7.94E-02	1.473	0.929	0.097	(+)	0.2607
INTER	9.98E-02	0.1041	0.9583	0.831	0.063	(-) and (+)	0.0419
AREA	-0.17628	0.1669	-1.056	0.146	-0.069	(-) or (+)	-0.0429
COUNTY	-1.89E-02	1.75E-02	-1.076	0.142	-0.071	(-)	-0.1029
OUTLIER	-2.3381	0.2136	-10.94	0.000	-0.585	(-)	-0.0755
CONSTANT	0.23133	0.1492	1.55	0.939	0.102		0.8999
R^2	0.5040						
sample size	268						

*Dependent Variable is State^{RIMS}-Park^{RIMS}

**H$_0$: Coefficient on IMPLAN = 1, $t = \dfrac{0.42698 - 1}{0.2301} = -2.49, \quad < t_c = -1.96$ on IMPLAN

Reject H$_0$

C.2 Model *1B**

Variable Name	Estimated Coefficient	Standard Error	T-ratio 208 DF	P-value	Partial Correlation.	Expected Sign	Elasticity at Means
IMPLAN[19]	0.51851	0.207	2.505	0.994	0.159	+, > 1	0.4793
POP	-8.94E-04	1.26E-03	-0.7115	0.239	-0.046	(-)	-0.0061
SECTOR	-0.14005	0.2008	-0.6974	0.243	-0.045	(-)	-0.2106
METRO	-2.02E-02	8.10E-02	-0.2492	0.402	-0.16	(-)	-0.0319
POPRATIO	0.10859	4.13E-02	2.628	0.995	0.166	(-)	0.0992
RURAL	0.19312	7.23E-02	2.67	0.996	0.169	(+)	0.3984
INTER	3.63E-03	9.45E-02	3.85E-02	0.515	0.002	(-) and (+)	0.0015
AREA	-0.18095	0.1622	-1.115	0.133	-0.071	(-) or (+)	-0.0373
COUNTY	7.59E-03	3.41E-02	0.2223	0.588	0.014	(-)	0.0314
OUTLIER	-1.618	0.2884	-5.61	0.000	-0.339	(-)	-0.0223
CONSTANT	8.54E-02	0.1445	0.5912	0.723	0.038		0.2984
R^2	0.3547						
sample size	254						

*Dependent Variable is State^{RIMS}-Park^{RIMS}

**H$_0$: Coefficient on IMPLAN = 1, $t = \dfrac{0.51851 - 1}{0.207} = -2.33, \quad < t_c = -1.96$ on IMPLAN

Reject H$_0$

[13] In models 1A, 1B, 1C, and 1D IMPLAN refers to State^{IMPLAN}-County^{IMPLAN}.

C.3 Model *1C**

Variable Name	Estimated Coefficient	Standard Error	T-ratio 208 DF	P-value	Partial Correlation.	Expected Sign	Elasticity at Means
IMPLAN[19]	0.45019	0.2172	2.073	0.98	0.143	+, > 1	0.4355
POP	-9.58E-04	1.72E-03	-0.5566	0.289	-0.039	(-)	-0.0053
SECTOR	-0.19135	0.2147	-0.8911	0.187	-0.062	(-)	-0.2913
METRO	-4.28E-02	8.13E-02	-0.527	0.299	-0.037	(-)	-0.0696
POPRATIO	0.12507	4.15E-02	3.015	0.999	0.205	(-)	0.1327
RURAL	0.19386	7.23E-02	2.682	0.996	0.183	(+)	0.3922
INTER	3.34E-02	9.99E-02	0.3342	0.631	0.023	(-) and (+)	0.0122
AREA	-0.24928	0.166	-1.501	0.067	-0.104	(-) or (+)	-0.0518
OUTLIER	-1.6232	0.2854	-5.687	0.000	-0.368	(-)	-0.0269
CONSTANT	0.13125	0.1498	0.8759	0.809	0.061		0.4723
R^2	0.3924						
sample size	217						

*Dependent Variable is State^{RIMS}-Park^{RIMS}

**H_0: Coefficient on IMPLAN = 1, $t = \dfrac{0.45019-1}{0.2172} = -2.53, \quad < t_c = -1.96$ on IMPLAN

Reject H_0

C.4 Model *1D**

Variable Name	Estimated Coefficient	Standard Error	T-ratio 208 DF	P-value	Partial Correlation.	Expected Sign	Elasticity at Means
IMPLAN[19]	0.40863	0.1919	2.129	0.983	0.15	+, > 1	0.3404
POP	7.22E-08	5.09E-08	1.419	0.921	0.1	(-)	0.0113
SECTOR	2.26E-04	9.98E-05	2.268	0.988	0.159	(-)	0.0252
METRO	3.09E-02	7.98E-02	0.3871	0.65	0.028	(-)	0.0082
POPRATIO	-0.12381	2.83E-02	-4.369	0.000	-0.297	(-)	-0.0212
RURAL	-0.19023	8.11E-02	-2.345	0.010	-0.164	(+)	-0.0593
INTER	2.82E-02	0.1126	0.2508	0.599	0.018	(-) and (+)	0.0017
AREA	-2.45E-05	6.62E-06	-3.706	0.000	-0.255	(-) or (+)	-0.0307
OUTLIER	1.5669	7.36E-02	21.3	1	0.834	(-)	0.0043
CONSTANT	1.2666	0.2776	4.563	1	0.308		0.72
R^2	0.4784						
sample size	208						

*Dependent Variable is State^{RIMS}-Park^{RIMS}

**H_0: Coefficient on IMPLAN = 1, $t = \dfrac{0.40863-1}{0.1919} = -3.08, \quad < t_c = -1.96$ on IMPLAN

Reject H_0

C.5 Model *2A**

Variable Name	Estimated Coefficient	Standard Error	T-ratio 208 DF	P-value	Partial Correlation.	Expected Sign	Elasticity at Means
IMPLAN	0.42897	0.172	2.494	0.993	0.154	+, < 1	0.3565
POP	4.93E-09	1.74E-08	0.2834	0.611	0.018	(+)	0.0016
SECTOR	3.27E-04	1.42E-04	2.308	0.989	0.142	(+)	0.0377
METRO	8.07E-02	8.21E-02	0.9823	0.837	0.061	(+)	0.0216
POPRATIO	-0.12092	2.85E-02	-4.243	0.000	-0.256	(+)	-0.0184
RURAL	-0.15024	8.19E-02	-1.834	0.034	-0.114	(-)	-0.0485
INTER	3.47E-03	0.1022	3.39E-02	0.514	0.002	(-) and (+)	0.0002
AREA	-1.79E-05	3.61E-06	-4.955	0.000	-0.295	(-) or (+)	-0.0307
COUNTY	2.03E-02	2.12E-02	0.9604	0.831	0.06	(+)	0.0165
OUTLIER	2.287	0.4774	4.791	1	0.286	(+)	0.0096
CONSTANT	1.1568	0.2476	4.673	1	0.28		0.6538
R^2	0.5554						
sample size	268						

*Dependent variable is $Park^{RIMS}$

**H_0: Coefficient on IMPLAN = 1, $t = \dfrac{0.42897 - 1}{0.172} = -3.32, \quad < t_c = -1.96$ on IMPLAN

Reject H_0

C.6 Model *2B**

Variable Name	Estimated Coefficient	Standard Error	T-ratio 208 DF	P-value	Partial Correlation.	Expected Sign	Elasticity at Means
IMPLAN	0.43202	0.1703	2.537	0.994	0.161	+, < 1	0.3624
POP	3.52E-08	1.32E-08	2.664	0.996	0.168	(+)	0.0062
SECTOR	2.66E-04	1.25E-04	2.131	0.983	0.135	(+)	0.0298
METRO	2.19E-02	7.87E-02	0.2779	0.609	0.018	(+)	0.0057
POPRATIO	-0.11377	2.95E-02	-3.86	0.000	-0.240	(+)	-0.017
RURAL	-0.19446	7.96E-02	-2.444	0.008	-1.155	(-)	-0.0657
INTER	7.09E-02	0.1013	0.7005	0.758	0.045	(-) and (+)	0.0048
AREA	-1.95E-05	4.07E-06	-4.794	0.000	-0.294	(-) or (+)	-0.0315
COUNTY	3.40E-02	2.85E-02	1.195	0.883	0.076	(+)	0.023
OUTLIER	1.5728	7.36E-02	21.37	1	0.808	(+)	0.0035
CONSTANT	1.1872	0.2485	4.778	1	0.293		0.6788
R^2	0.4362						
sample size	254						

*Dependent variable is $Park^{RIMS}$

**H_0: Coefficient on IMPLAN = 1, $t = \dfrac{0.43202 - 1}{0.1703} = -3.34, \quad < t_c = -1.96$ on IMPLAN

Reject H_0

C.7 Model *2C**

Variable Name	Estimated Coefficient	Standard Error	T-ratio 208 DF	P-value	Partial Correlation.	Expected Sign	Elasticity at Means
IMPLAN	0.3048	0.2646	1.152	0.875	0.08	+, < 1	0.2537
POP	4.72E-08	5.96E-08	0.792	0.785	0.055	(+)	0.0071
SECTOR	6.17E-04	5.60E-04	1.104	0.864	0.076	(+)	0.0659
METRO	3.99E-03	8.03E-02	4.97E-02	0.52	0.003	(+)	0.001
POPRATIO	-0.12585	4.02E-02	-3.129	0.001	-0.213	(+)	-0.0211
RURAL	-0.19317	7.12E-02	-2.714	0.004	-0.185	(-)	-0.0619
INTER	4.04E-02	9.60E-02	0.4209	0.663	0.029	(-) and (+)	0.0023
AREA	-2.53E-05	5.50E-06	-4.597	0.000	-0.304	(-) or (+)	-0.0318
OUTLIER	1.5463	0.2765	5.593	1	0.362	(+)	0.0041
CONSTANT	1.3702	0.3227	4.246	1	0.283		0.7806
R^2	0.4682						
sample size	217						

*Dependent variable is $Park^{RIMS}$

**H_0: Coefficient on IMPLAN = 1, $t = \dfrac{0.3048 - 1}{0.2646} = -2.63, \quad < t_c = -1.96$ on IMPLAN

Reject H_0

C.8 Model *2D**

Variable Name	Estimated Coefficient	Standard Error	T-ratio 208 DF	P-value	Partial Correlation.	Expected Sign	Elasticity at Means
IMPLAN	0.38323	0.2333	1.642	0.949	0.116	+, < 1	0.3191
POP	1.08E-07	8.28E-08	1.302	0.903	0.092	(+)	0.0119
SECTOR	2.83E-04	4.44E-04	0.6373	0.738	0.045	(+)	0.0292
METRO	7.57E-03	8.20E-02	9.23E-02	0.537	0.007	(+)	0.0019
POPRATIO	-0.12617	2.89E-02	-4.369	0.000	-0.297	(+)	-0.0206
RURAL	-0.18253	7.67E-02	-2.38	0.009	-0.167	(-)	-0.0604
INTER	3.92E-03	0.1112	3.53E-02	0.514	0.003	(-) and (+)	0.0002
AREA	-3.17E-05	5.68E-06	-5.58	0.000	-0.369	(-) or (+)	-0.0393
OUTLIER	1.5435	7.12E-02	21.67	1	0.839	(+)	0.0043
CONSTANT	1.3135	0.3048	4.31	1	0.293		0.7537
R^2	0.4802						
sample size	208						

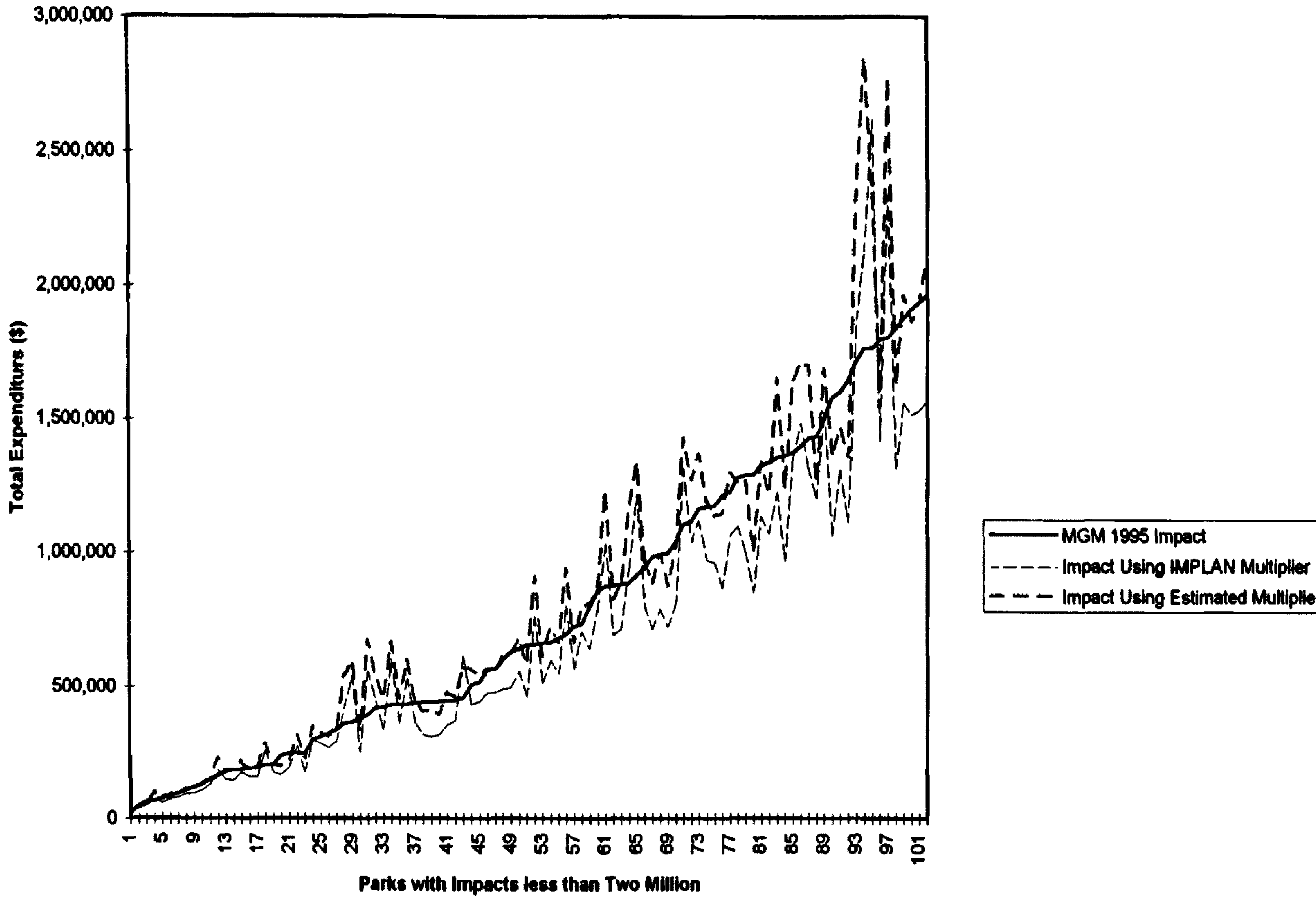
*Dependent variable is $Park^{RIMS}$

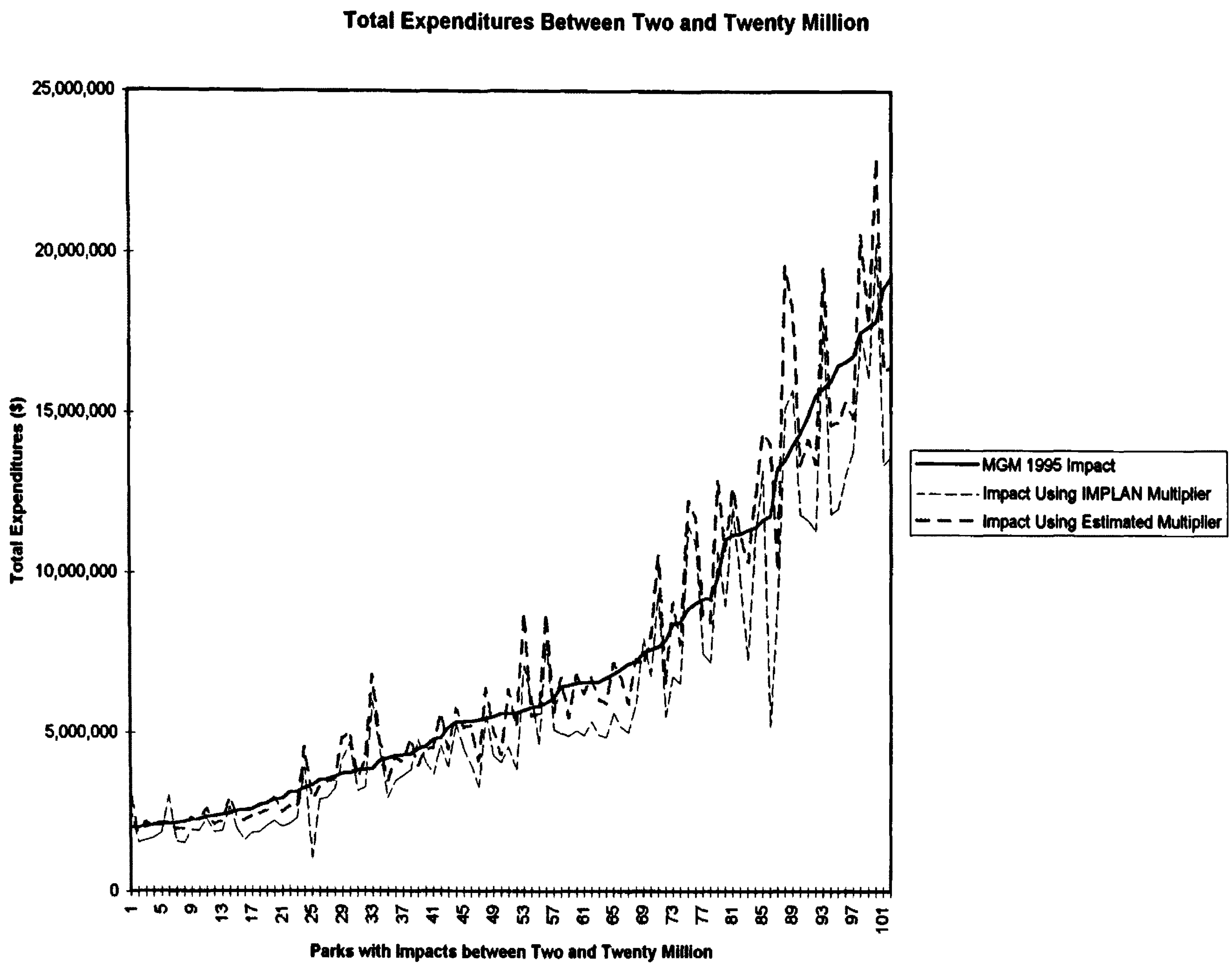
**H_0: Coefficient on IMPLAN = 1, $t = \dfrac{0.38323 - 1}{0.233} = -2.64, \quad < t_c = -1.96$ on IMPLAN

Reject H_0

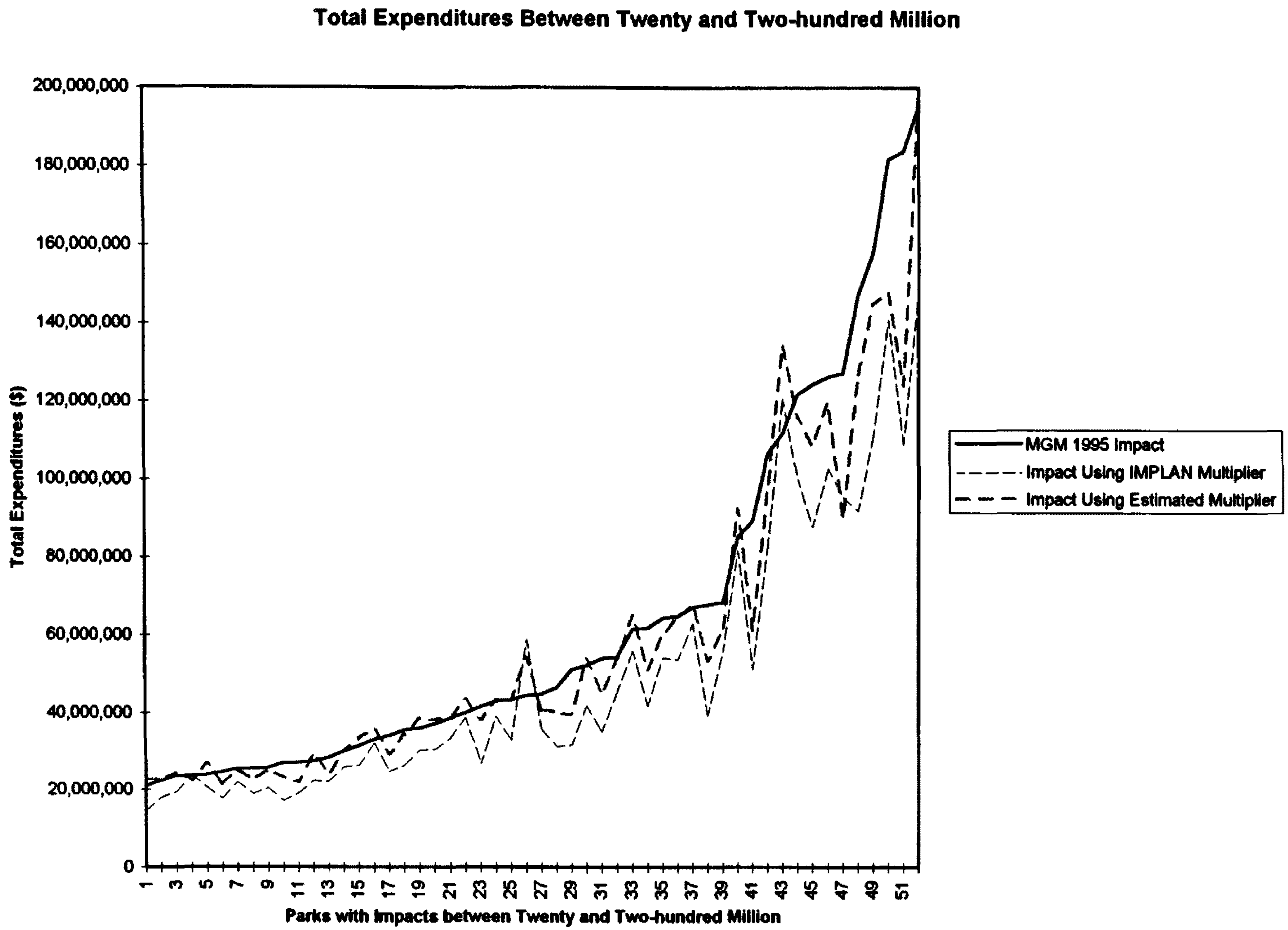
Appendix D: MGM Impacts with Alternative Multipliers

Total Expenditures Less Than Two Million

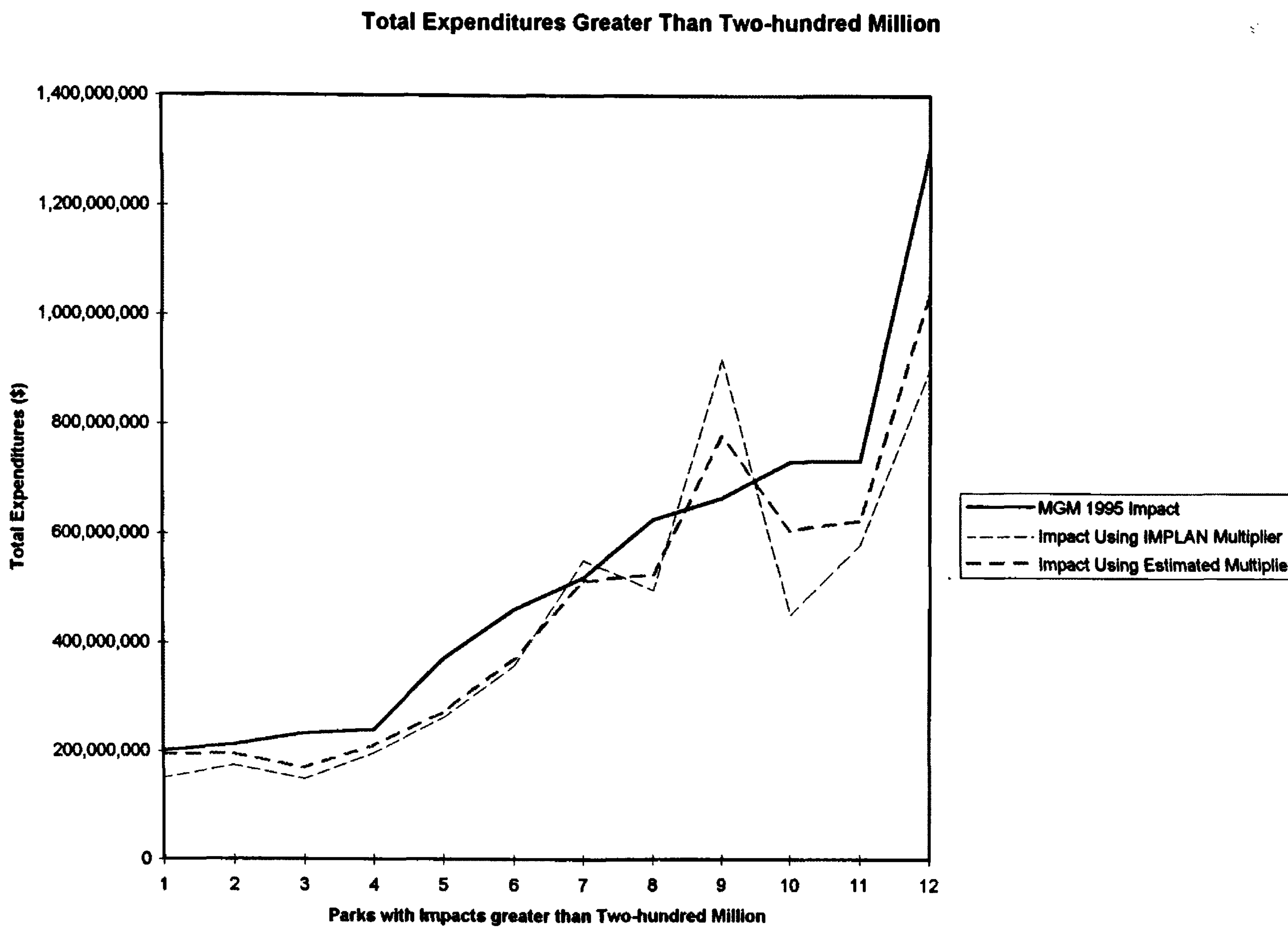




Total Expenditures Between Two and Twenty Million
25,000,000
20,000,000
15,000,000
10,000,000
5,000,000
0
Total Expenditures ($)
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
81
85
89
93
97
101
Parks with Impacts between Two and Twenty Million
MGM 1995 Impact
Impact Using IMPLAN Multiplier
Impact Using Estimated Multiplier



Total Expenditures Between Twenty and Two-hundred Million
Total Expenditures ($)
200,000,000
180,000,000
160,000,000
140,000,000
120,000,000
100,000,000
80,000,000
60,000,000
40,000,000
20,000,000
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51
Parks with Impacts between Twenty and Two-hundred Million
MGM 1995 Impact
Impact Using IMPLAN Multiplier
Impact Using Estimated Multiplier



Total Expenditures Greater Than Two-hundred Million
1,400,000,000
1,200,000,000
1,000,000,000
800,000,000
600,000,000
400,000,000
200,000,000
0
Total Expenditures ($)
1
2
3
4
5
6
7
8
9
10
11
12
Parks with impacts greater than Two-hundred Million
MGM 1995 Impact
Impact Using IMPLAN Multiplier
Impact Using Estimated Multiplier

Appendix E: Correlation Matrices

E.1 Correlation Matrix: Model 1A

	IMPLAN	POP	SECTORS	METRO	POPRATIO
IMPLAN	1	-0.16025	-0.76805	-0.45079	-0.06002
POP	-0.16025	1	0.17382	0.13009	-0.01392
SECTORS	-0.76805	0.17382	1	0.64403	0.15206
METRO	-0.45079	0.13009	0.64403	1	0.15029
POPRATIO	-0.06002	-0.01392	0.15206	0.15029	1
RURAL	0.33884	-0.05722	-0.55147	-0.62664	-0.22129
INTERAC	-0.06209	0.08523	0.02985	0.38108	-0.13975
AREA	-0.20058	-0.01862	0.0954	-0.16269	-0.10014
COUNTIES	-0.13636	-0.007	0.41512	0.17589	0.0789
Y	0.38126	-0.08377	-0.43492	-0.30051	0.02

	RURAL	INTERAC	AREA	COUNTIES	Y
IMPLAN	0.33884	-0.06209	-0.20058	-0.13636	0.38126
POP	-0.05722	0.08523	-0.01862	-0.007	-0.08377
SECTORS	-0.55147	0.02985	0.0954	0.41512	-0.43492
METRO	-0.62664	0.38108	-0.16269	0.17589	-0.30051
POPRATIO	-0.22129	-0.13975	-0.10014	0.0789	0.02
RURAL	1	0.31355	0.19871	-0.13852	0.37989
INTERAC	0.31355	1	-0.03111	-0.01255	0.05852
AREA	0.19871	-0.03111	1	-0.01383	-0.04657
COUNTIES	-0.13852	-0.01255	-0.01383	1	-0.24625
Y	0.37989	0.05852	-0.04657	-0.24625	1

E.2 Correlation Matrix: Model 1B

	IMPLAN	POP	SECTORS	METRO	POPRATIO
IMPLAN	1	-0.16656	-0.78896	-0.45243	-0.0383
POP	-0.16656	1	0.20447	0.13888	-0.01241
SECTORS	-0.78896	0.20447	1	0.64706	0.09179
METRO	-0.45243	0.13888	0.64706	1	0.12927
POPRATIO	-0.0383	-0.01241	0.09179	0.12927	1
RURAL	0.32169	-0.06353	-0.5251	-0.60983	-0.1985
INTERAC	-0.09107	0.08611	0.07957	0.40234	-0.13217
AREA	-0.20152	-0.01904	0.11233	-0.168	-0.09586
COUNTIES	-0.04319	0.0356	0.07702	-0.00414	-0.15452
Y	0.40545	-0.10799	-0.41232	-0.30373	0.07871

	RURAL	INTERAC	AREA	COUNTIES	Y
IMPLAN	0.32169	-0.09107	-0.20152	-0.04319	0.40545
POP	-0.06353	0.08611	-0.01904	0.0356	-0.10799
SECTORS	-0.5251	0.07957	0.11233	0.07702	-0.41232
METRO	-0.60983	0.40234	-0.168	-0.00414	-0.30373
POPRATIO	-0.1985	-0.13217	-0.09586	-0.15452	0.07871
RURAL	1	0.30472	0.20257	0.13872	0.3926
INTERAC	0.30472	1	-0.03734	0.12458	0.03984
AREA	0.20257	-0.03734	1	0.02999	-0.05967
COUNTIES	0.13872	0.12458	0.02999	1	0.0176
Y	0.3926	0.03984	-0.05967	0.0176	1

E.3 Correlation Matrix: Model 1C

	IMPLAN	POP	SECTORS	METRO	POPRATIO
IMPLAN	1	-0.13877	-0.79143	-0.45717	-0.0676
POP	-0.13877	1	0.1732	0.13563	0.0077
SECTORS	-0.79143	0.1732	1	0.65257	0.13377
METRO	-0.45717	0.13563	0.65257	1	0.15307
POPRATIO	-0.0676	0.0077	0.13377	0.15307	1
RURAL	0.32145	-0.00848	-0.51714	-0.61776	-0.19047
INTERAC	-0.09094	0.17027	0.08891	0.37013	-0.11581
AREA	-0.21575	-0.03281	0.13641	-0.17219	-0.09114
Y	0.41095	-0.07289	-0.42644	-0.31621	0.09522

	RURAL	INTERAC	AREA	Y
IMPLAN	0.32145	-0.09094	-0.21575	0.41095
POP	-0.00848	0.17027	-0.03281	-0.07289
SECTORS	-0.51714	0.08891	0.13641	-0.42644
METRO	-0.61776	0.37013	-0.17219	-0.31621
POPRATIO	-0.19047	-0.11581	-0.09114	0.09522
RURAL	1	0.2964	0.19427	0.41117
INTERAC	0.2964	1	-0.06421	0.05099
AREA	0.19427	-0.06421	1	-0.08959
Y	0.41117	0.05099	-0.08959	1

E.4 Correlation Matrix: Model 1D

	IMPLAN	POP	SECTORS	METRO	POPRATIO
IMPLAN	1	-0.08665	-0.51296	-0.44443	-0.07197
POP	-0.08665	1	0.06265	0.1539	0.09539
SECTORS	-0.51296	0.06265	1	0.35576	0.08883
METRO	-0.44443	0.1539	0.35576	1	0.13626
POPRATIO	-0.07197	0.09539	0.08883	0.13626	1
RURAL	0.32936	-0.13309	-0.39636	-0.61652	-0.16313
INTERAC	-0.05979	-0.01399	0.01908	0.37715	-0.09705
AREA	-0.22365	-0.04774	0.08682	-0.16528	-0.08099
Y	0.40762	-0.10692	-0.31233	-0.31165	0.09645

	RURAL	INTERAC	AREA	Y
IMPLAN	0.32936	-0.05979	-0.22365	0.40762
POP	-0.13309	-0.01399	-0.04774	-0.10692
SECTORS	-0.39636	0.01908	0.08682	-0.31233
METRO	-0.61652	0.37715	-0.16528	-0.31165
POPRATIO	-0.16313	-0.09705	-0.08099	0.09645
RURAL	1	0.27931	0.18386	0.41949
INTERAC	0.27931	1	-0.07706	0.0673
AREA	0.18386	-0.07706	1	-0.09062
Y	0.41949	0.0673	-0.09062	1

E.5 Correlation Matrix: Model 2A

	IMPLAN	POP	SECTORS	METRO	POPRATIO
IMPLAN	1	0.35624	0.64527	0.65779	0.11718
POP	0.35624	1	0.52408	0.32595	0.16247
SECTORS	0.64527	0.52408	1	0.52939	0.14576
METRO	0.65779	0.32595	0.52939	1	0.15029
POPRATIO	0.11718	0.16247	0.14576	0.15029	1
RURAL	-0.5006	-0.32633	-0.53866	-0.62664	-0.22129
INTERAC	0.14885	-0.05765	0.03001	0.38108	-0.13975
AREA	-0.01798	-0.02087	-0.05088	-0.14024	-0.16424
COUNTIES	0.17139	0.81222	0.35271	0.17589	0.0789
Y	0.39669	0.34858	0.40926	0.38823	0.01623

	RURAL	INTERAC	AREA	COUNTIES	Y
IMPLAN	-0.5006	0.14885	-0.01798	0.17139	0.39669
POP	-0.32633	-0.05765	-0.02087	0.81222	0.34858
SECTORS	-0.53866	0.03001	-0.05088	0.35271	0.40926
METRO	-0.62664	0.38108	-0.14024	0.17589	0.38823
POPRATIO	-0.22129	-0.13975	-0.16424	0.0789	0.01623
RURAL	1	0.31355	0.30367	-0.13852	-0.46524
INTERAC	0.31355	1	0.16194	-0.01255	-0.02642
AREA	0.30367	0.16194	1	0.09838	-0.27762
COUNTIES	-0.13852	-0.01255	0.09838	1	0.24732
Y	-0.46524	-0.02642	-0.27762	0.24732	1

E.6 Correlation Matrix: Model 2B

	IMPLAN	POP	SECTORS	METRO	POPRATIO
IMPLAN	1	0.46933	0.63527	0.65202	0.09133
POP	0.46933	1	0.45862	0.36997	0.01443
SECTORS	0.63527	0.45862	1	0.50715	0.08894
METRO	0.65202	0.36997	0.50715	1	0.12927
POPRATIO	0.09133	0.01443	0.08894	0.12927	1
RURAL	-0.47828	-0.3328	-0.50736	-0.60983	-0.1985
INTERAC	0.17585	0.00186	0.06663	0.40234	-0.13217
AREA	-0.00159	0.00528	-0.04937	-0.18021	-0.14988
COUNTIES	0.0592	0.0862	0.04381	-0.00414	-0.15452
Y	0.4135	0.29167	0.38511	0.4096	-0.04513

	RURAL	INTERAC	AREA	COUNTIES	Y
IMPLAN	-0.47828	0.17585	-0.00159	0.0592	0.4135
POP	-0.3328	0.00186	0.00528	0.0862	0.29167
SECTORS	-0.50736	0.06663	-0.04937	0.04381	0.38511
METRO	-0.60983	0.40234	-0.18021	-0.00414	0.4096
POPRATIO	-0.1985	-0.13217	-0.14988	-0.15452	-0.04513
RURAL	1	0.30472	0.3268	0.13872	-0.48223
INTERAC	0.30472	1	0.13081	0.12458	0.01524
AREA	0.3268	0.13081	1	0.2411	-0.31593
COUNTIES	0.13872	0.12458	0.2411	1	-0.00391
Y	-0.48223	0.01524	-0.31593	-0.00391	1

E.7 Correlation Matrix: Model 2C

	IMPLAN	POP	SECTORS	METRO	POPRATIO
IMPLAN	1	0.607	0.86236	0.65539	0.13203
POP	0.607	1	0.73394	0.52586	0.09367
SECTORS	0.86236	0.73394	1	0.72864	0.13935
METRO	0.65539	0.52586	0.72864	1	0.15307
POPRATIO	0.13203	0.09367	0.13935	0.15307	1
RURAL	-0.46911	-0.42583	-0.59858	-0.61776	-0.19047
INTERAC	0.19645	0.06506	0.12096	0.37013	-0.11581
AREA	-0.02283	-0.02516	-0.06121	-0.24444	-0.11136
Y	0.41174	0.34883	0.45972	0.41838	-0.05511

	RURAL	INTERAC	AREA	Y
IMPLAN	-0.46911	0.19645	-0.02283	0.41174
POP	-0.42583	0.06506	-0.02516	0.34883
SECTORS	-0.59858	0.12096	-0.06121	0.45972
METRO	-0.61776	0.37013	-0.24444	0.41838
POPRATIO	-0.19047	-0.11581	-0.11136	-0.05511
RURAL	1	0.2964	0.32561	-0.50384
INTERAC	0.2964	1	0.03898	0.00406
AREA	0.32561	0.03898	1	-0.34583
Y	-0.50384	0.00406	-0.34583	1

E.8 Correlation Matrix: Model 2D

	IMPLAN	POP	SECTORS	METRO	POPRATIO
IMPLAN	1	0.6889	0.84682	0.6316	0.10953
POP	0.6889	1	0.83989	0.65867	0.08417
SECTORS	0.84682	0.83989	1	0.72015	0.11475
METRO	0.6316	0.65867	0.72015	1	0.13626
POPRATIO	0.10953	0.08417	0.11475	0.13626	1
RURAL	-0.4655	-0.58248	-0.62052	-0.61652	-0.16313
INTERAC	0.1768	0.02251	0.08667	0.37715	-0.09705
AREA	-0.05925	-0.11114	-0.11983	-0.28377	-0.09388
Y	0.38402	0.40435	0.43622	0.39729	-0.07291

	RURAL	INTERAC	AREA	Y
IMPLAN	-0.4655	0.1768	-0.05925	0.38402
POP	-0.58248	0.02251	-0.11114	0.40435
SECTORS	-0.62052	0.08667	-0.11983	0.43622
METRO	-0.61652	0.37715	-0.28377	0.39729
POPRATIO	-0.16313	-0.09705	-0.09388	-0.07291
RURAL	1	0.27931	0.32312	-0.5014
INTERAC	0.27931	1	-0.03423	-0.01097
AREA	0.32312	-0.03423	1	-0.40849
Y	-0.5014	-0.01097	-0.40849	1

Appendix F

F.1 A Foundation for Input-Output Analysis: Economic Base Theory

Before discussing input-output (I/O) models, a discussion of economic base theory is in order. Understanding economic base theory is important to understanding I/O models because I/O analysis springs from economic base theory. It helps to think of I/O models as simply mathematically sophisticated economic base models.

The central concept of economic base theory is that total economic activity can be broken up into basic economic activity (activities devoted to producing goods and services ultimately sold to consumers outside the region which bring financial flows into the local economy) and non-basic economic activity (activities involved in producing goods and services for local consumption) (Krikelas 1992). The concept of basic and non-basic sectors can be written mathematically as:

$$T = B + N \tag{F.1}$$

where: T = Total economic activity

B = Basic economic activity

N = Non-basic economic activity

The fundamental causal relationship assumed is that non-basic economic activity depends on basic economic activity.

$$N = f(B) = a + bB \tag{F.2}$$

Under this assumption, the primary impetus for regional economic growth is export activity. External demand for a regions exportable goods and services injects income into the region's economy, augmenting local demand for non-exportable goods and services. Combining equation F.1 and F.2 indicates that total economic activity is primarily a function of basic economic activity:

$$T = a + (1 + b)B \tag{F.3}$$

The expression *(1 + b)* is the economic base multiplier. Since this is a constant, economies can only grow by increasing exports.

By the mid-1950's the potential inaccuracy of the economic base theory's division of basic and non-basic industries was widely recognized. The division assumes that growth in a basic industry will cause equal proportional growth across all non-basic industries while not affecting any other basic industry. Modelers recognized that growth in one industry may positively impact some industry, while negatively impacting other industry. For example, increased mining operation may positively impact local heavy machinery dealers, while decimating the local tourism industry. Modelers also recognized the circularity of impacts. The increased wages and profits that result from an expanding industry paying its workers and suppliers are respent in the local economy. Suppliers and wage earners may find themselves purchasing more goods and services from the very company that created their increased profits and wages. The initial stimulus in the economy became known as primary impact while the recalculation of the stimulus was termed secondary impact.

The recognition of this circular dynamic and more complex sectoral impacts in an economy instigated the adaptation of input-output models to regional economic analyses. I/O models attempt to follow the circular dynamic of money that is respent and respent in a community. I/O models, however, do not stray far from their predecessors in that they continue to view economic growth as export driven.

F.2 Input-Output Methodology

F.2.1 Assumptions

Input-output modeling is based on a number of key assumptions (IMPRO 87-88):

1. Constant Returns to Scale
2. No Supply constraints
3. Fixed Commodity Input Structure
4. Homogenous Sector Output
5. Industry Technology Assumption

The first assumption of *constant returns to scale* means that the industry production functions are assumed to be linear homogenous; proportional increases in input leads to proportional increases in output. The next assumption of *no supply constraints* means that an industry has unlimited access to its needed inputs at a fixed price. The third assumption of a *fixed commodity input structure* refers to the exclusion of substituting inputs. A change in output will not affect the mix of commodities and services used to produce an industry's output . *Homogenous sector output* assumes mix of commodities produced by an industry remain the same regardless of total output. Finally, the *industry technology assumption* means that an industry does not change its technology as it changes its level of production.

As mentioned earlier in the literature review, the trade flow assumptions are among the primary differences between the RIMS II and IMPLAN models. Trade flows refer to the movement of goods and services between the region and the outside world. In other words, they describe how much of a locally produced commodity will be used to satisfy local demand and how much will be exported from the region. IMPLAN uses

Regional Purchase Coefficients (RPC) while RIMS II implements location quotients (LQ).

Compared to the LQ method, the RPC technique is a more sophisticated method of estimating the proportion of local demand satisfied by local producers. Unfortunately, the most that can be said about calculating RPCs is that they are econometrically estimated based on the characteristics of the region. There is a different equation for every commodity and the exact estimation technique and formulas are not published. The LQ method, on the other hand, is a fixed equation that simply compares the regional and national production ratios.

F.2.2 The Mechanics of Input-Output Analysis

To construct an I/O model, information on the sales and purchases of firms in a region is needed. RIMS II and IMPLAN utilize nationally constructed accounting systems to gather their data. The type and organization of the information these two models utilize can most easily be seen in the hypothetical construction of a survey based I/O model.

To begin constructing a regional I/O model, firms are asked to detail:

1. Total purchases of goods and the industrial sectors from which it purchases these goods, irrespective of geographical origin;
2. Purchases of goods from within the region;
3. Total sales to industrial sectors purchasing a firms output, irrespective of geographical region;
4. Sales of a firms output within the region.

The information provided by firms includes data on purchases of labor and returns to capital (profits, dividends, and taxes), sales to consumers and governments, and investment purchases. From the survey information provided by firms, four matrices are constructed that describe the four sets of information collected from firms.

The next step is to combine the matrices showing sale and purchase relations irrespective of origin and to combine the matrices showing relations within the region. The combining of the four original matrices into two matrices will involve some reconciliation of estimates. I/O modeling is a system in which total input must equal total output. Since the data often involves merely estimates, some entries may need to be changed in order to ensure balance is maintained.

The two combined matrices are distinct enough that the literature reserves names for them. The first matrix which shows total transactions irrespective of origin is referred to as the *total technology matrix*. The second matrix which shows only transactions within the region is regarded as the *regional transactions matrix*. I/O analysis concentrates on the regional transactions matrix, so the total technology matrix is usually aggregated into one- or two-row vectors[14]. A skeleton I/O table will look like Figure F-1. The row entries represent sales from various sectors, while the column entries represent the sectors that purchase output. The import and export entries represent the aggregated total technology matrix.

[14] The row vector is placed within the accounting system as imports and exports so that the extraregional transactions are not lost.

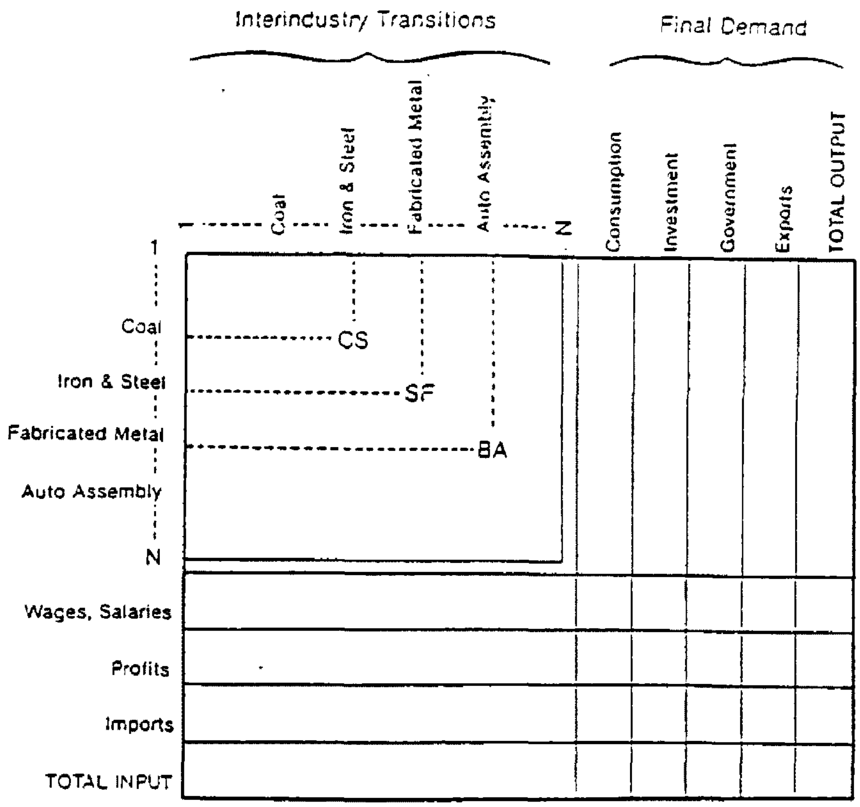


Figure F-1: Skeleton Input-Output Table[15]

The next step is to turn the I/O table into an analytical model. This is done by first aggregating the sectors of final demand columns into a single column, f_i. Then total input/output for sector i can be written:

$$X_i = \sum X'_{ij} + f_i \tag{F.4}$$

where X_i = total input/output for sector I

X'_{ij} = flow of commodities from industry i to industry j within the region

f_i = final demand for commodities from sector i.

[15] Reproduced from Hewings (1985) page 24.

The assumptions mentioned previously, concerning independence of the demand for inputs to the level of output and the exclusion of substituting, enables the construction of a regional purchase coefficient:

$$r_{ij} = \frac{X'_{ij}}{X_j} \tag{F.5}$$

Substituting this expression into equation 3.4 yields:

$$X_i = \sum r_{ij} X_j + f_i \tag{F.6}$$

Assuming the region has five sectors, the system of equations for the sectors can be expressed in matrix terms as:

$$\begin{matrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \end{matrix} = \begin{vmatrix} r_{11} & r_{12} & r_{13} & r_{14} & r_{15} \\ r_{21} & r_{22} & r_{23} & r_{24} & r_{25} \\ r_{31} & r_{32} & r_{33} & r_{34} & r_{35} \\ r_{41} & r_{42} & r_{43} & r_{44} & r_{45} \\ r_{51} & r_{52} & r_{53} & r_{54} & r_{55} \end{vmatrix} \bullet \begin{matrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \end{matrix} + \begin{matrix} f_1 \\ f_2 \\ f_3 \\ f_4 \\ f_5 \end{matrix} \tag{F.7}$$

Letting R represent the 5x5 matrix of r_{ij}; X represent the 5x1 vector of total input/output; and f be the 5x1 vector of final demands, equation (F.7) can be written:

$$RX + f = X \tag{F.8}$$

This equation can be rearranged and factored to derive a solution for the production of output in any industry, X:

$$f = X - RX$$

$$f = (I - R)X$$

$$X = (I - R)^{-1} f \tag{F.9}$$

The $(I\text{-}R)^{-1}$ is known as the Leontief inverse function. An examination of equation (F.9) reveals that the production of output in each industry theoretically involves purchases of inputs from all other industries. Of course, in reality a firm does not purchase inputs directly from every industry to produce its output. The key word is *directly*. Although direct linkages between firms may not exist, indirect linkages do exist. For example, Firm A may require five units of input from Firm B and no units from Firm C. Firm A and C do not seem to be linked at all. Firm B, however, requires two units from Firm C. Thus, Firms A and C are linked through Firm B. Mathematically the indirect links in subsequent rounds can be seen if equation (F.9) is rewritten as:

$$X = (I + R + R^2 + R^3 + R^4 + \ldots + R^t) f \qquad \text{(F.10)}$$

The various expressions of R represent the spending rounds. Because R is a coefficient matrix, as t goes to infinity, R^t approaches zero. This means that the contribution of each succeeding round diminishes.

At this point a numerical example may help to clarify the workings of input-output analysis. After collecting data from firms in a region, an I/O Table F-1 is constructed. From this table, regional purchase coefficients can be calculated to create Table F-2. This table indicates the direct linkages. Notice that sector two makes no direct purchases of inputs from sector one and sector five makes no direct purchases of inputs from sector one nor sector two. Indirect links, however, exist and they can be seen in the rounds of spending for an increase in output for sector two in Figure F-2.

Working through equation F.9 yields the Leontief inverse matrix, Table F-3. Summing the columns gives the multipliers for the individual sectors. What makes I/O models different from economic base models is that I/O models present multipliers for individual sectors, where as the economic base multiplier is a single multiplier for all basic sectors.

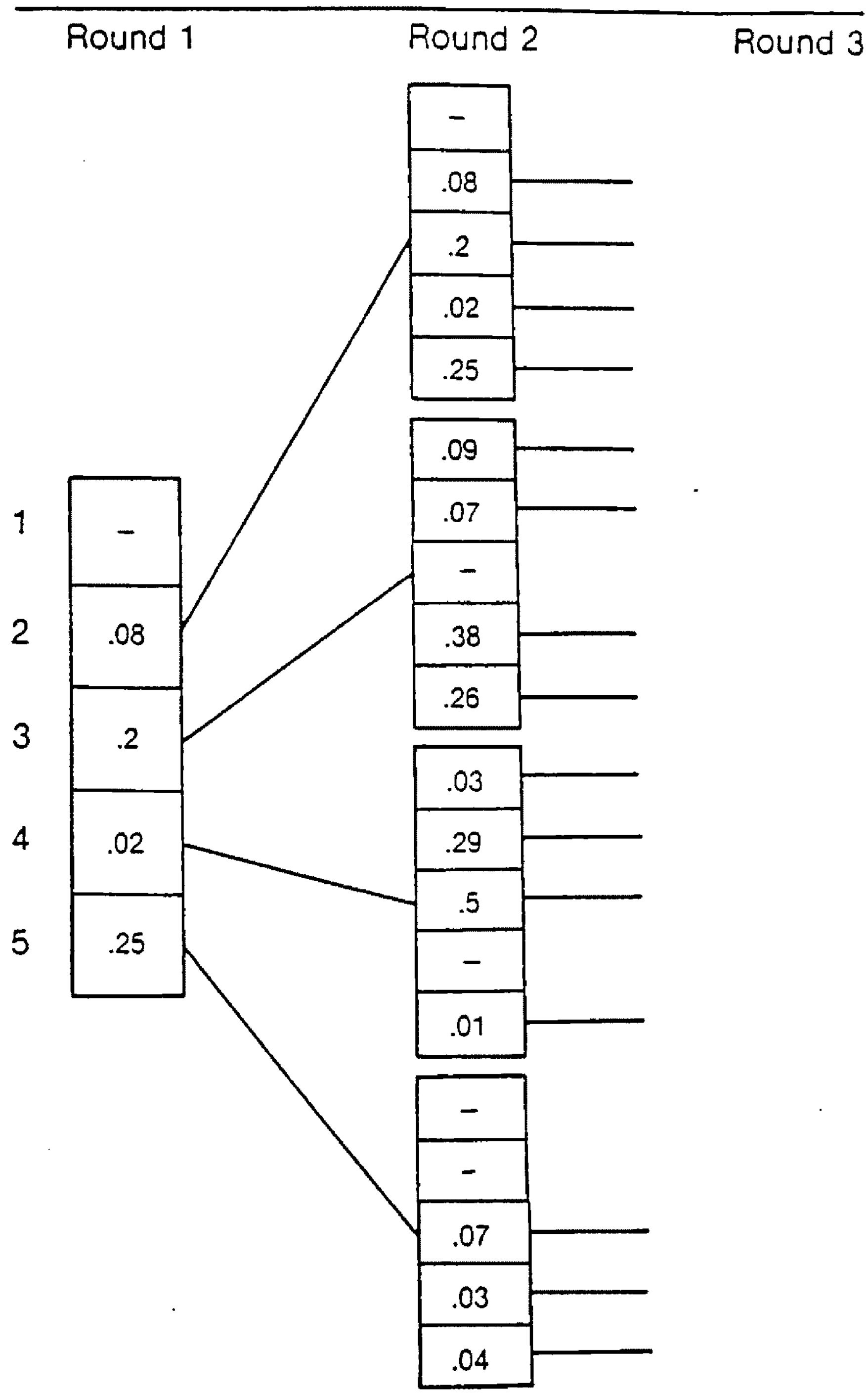


Figure F-2: Indirect Links in Sector Two[16]

[16] Reproduced from Hewings (1985) page 31.

		To										
		Producers						Final Demand				
		1	2	3	4	5	6	7	8	9	10	11
	From	Mining	Iron/ Steel	Electrical Engineering	Business Services	Transportation	Total Intermediate Sales	Households	State	Federal	Exports	Total Final Demand
1	Mining	21	–	9	3	–	33	30	10	5	22	67
2	Iron/steel	1	8	7	29	–	45	25	5	2	23	55
3	Electrical Engineering	3	20	–	50	7	80	5	1	8	6	20
4	Business Services	31	2	38	–	3	74	12	2	11	1	26
5	Transportation	10	25	26	1	4	66	9	6	13	6	34
6	Total intermediate purchases	66	55	80	83	14	298	81	24	39	–	–
7	Value added	20	40	10	17	40	–	2	49	13	–	–
8	Imports	14	5	10	–	46	–	77	20	35	–	–
9	Total input	100	100	100	100	100	–	160	93	87	–	–

Table F-1: Regional Input-Output Table[17]

[17] Reproduced from Hoover and Giarratani (1985)

Sectors	1	2	3	4	5
1	0.21	_	0.09	0.03	_
2	0.01	0.08	0.07	0.29	_
3	0.03	0.20	_	0.50	_
4	0.31	0.02	0.38	_	0.03
5	0.10	0.25	0.26	0.01	0.04

Table F-2: Regional Input Coefficient Matrix[18]

Sectors	1	2	3	4	5
1	1.33	0.05	0.18	0.15	0.02
2	0.23	1.17	0.30	0.50	0.04
3	0.40	0.36	1.41	0.82	0.13
4	0.58	0.19	0.61	1.38	0.09
5	0.31	0.41	0.48	0.38	1.09
Multiplier	2.85	2.18	2.98	3.23	1.37

Table F-3: Leontief Inverse Matrix and Output Multipliers[19]

[18] See footnote 18.
[19] See footnote 18.

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